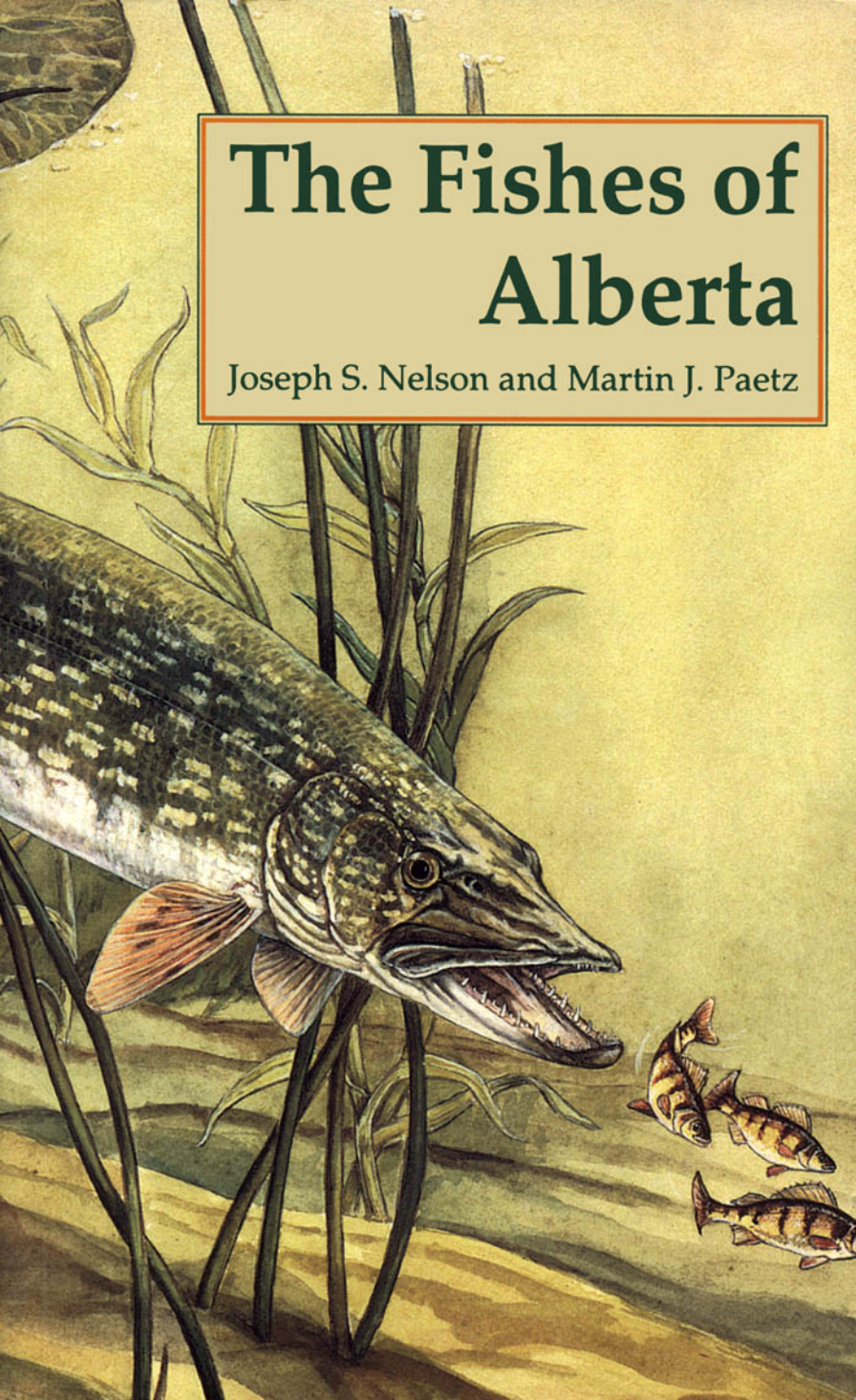
The Fishes of Alberta

Joseph S. Nelson and Martin J. Paetz



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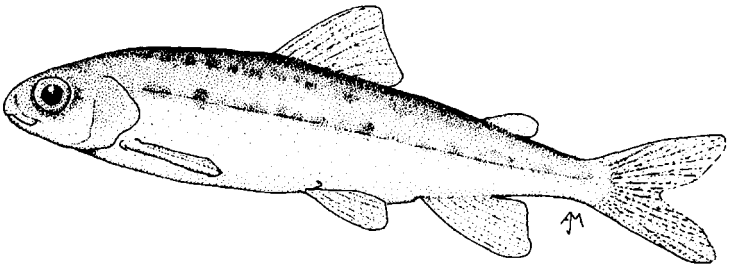

Joseph S. Nelson
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Contents

Preface **xi**
Acknowledgments **xv**
Introduction **xix**

I Alberta's Fishes

1 Fishing in Alberta **3**
1.1 The Milk River System **5**
1.2 The South Saskatchewan River System **5**
1.3 The North Saskatchewan River System **8**
1.4 The Athabasca River System **10**
1.5 The Beaver River System **12**
1.6 The Peace River System **13**
1.7 The Precambrian Shield Waters **15**

2 Fish Management in Alberta **17**
2.1 Management Practices **18**
2.2 History of Fish Culture in Alberta **21**
2.3 Trout Farming **27**

3 Fish Ecology **29**
3.1 Temperature and Dissolved Oxygen **30**
3.2 Types of Lakes **34**
3.3 Rivers and Streams **36**
3.4 Productivity of Lakes and Streams **43**
3.5 General Biology of Alberta Fish **43**

4 Post-Glacial Origin of Our Fish Fauna **47**
4.1 Glaciation in Alberta **48**
4.2 Refugia and Dispersal Routes **49**

5 The Species Concept, Classification, and Checklist **57**
5.1 Species **57**
5.2 Isolating Mechanisms **58**
5.3 Hybridization **59**
5.4 Genera and the Common and Scientific Name **60**
5.5 Families and Classification **64**
5.6 Checklist of Alberta Fishes **65**

6 Fish Species in Alberta, Evolution, and Fossils **69**
6.1 Numbers of Species and Families **69**
6.2 Evolution of Alberta Fish Families and Fossils **71**

7 Maps, Keys, and Definitions **75**
7.1 Distribution Maps **75**
7.2 How to Use the Keys **76**
7.3 Definitions of Fish Characteristics **77**

II The Fish Families of Alberta

8 Key to the 15 Families of Fishes of Alberta **87**

9 Lamprey Family—Petromyzontidae **93**
9.1 Arctic lamprey—*Lampetra japonica* (Martens) **95**

10 Sturgeon Family—Acipenseridae **97**
10.1 Lake sturgeon—*Acipenser fulvescens* Rafinesque **99**

11 Mooneye Family—Hiodontidae **103**
Key to the 2 Species **105**
11.1 Goldeye—*Hiodon alosoides* (Rafinesque) **106**
11.2 Mooneye—*Hiodon tergisus* Lesueur **111**

12 Minnow Family—Cyprinidae **115**
Key to the 14 Species **118**
12.1 Lake chub—*Couesius plumbeus* (Agassiz) **124**
12.2 Western silvery minnow—*Hybognathus argyritis* Girard **128**
12.3 Brassy minnow—*Hybognathus hankinsoni* Hubbs **132**
12.4 Pearl dace—*Margariscus margarita* (Cope) **136**
12.5 Emerald shiner—*Notropis atherinoides* Rafinesque **140**
12.6 River shiner—*Notropis blennius* (Girard) **144**
12.7 Spottail shiner—*Notropis hudsonius* (Clinton) **147**
12.8 Northern redbelly dace—*Phoxinus eos* (Cope) **151**
12.9 Finescale dace—*Phoxinus neogaeus* Cope **155**
12.10 Fathead minnow—*Pimephales promelas* Rafinesque **159**
12.11 Flathead chub—*Platygobio gracilis* (Richardson) **163**
12.12 Northern squawfish—*Ptychocheilus oregonensis* (Richardson) **167**
12.13 Longnose dace—*Rhinichthys cataractae* (Valenciennes) **170**
12.14 Redside shiner—*Richardsonius balteatus* (Richardson) **175**

13 Sucker Family—Catostomidae **179**
Key to the 7 Species **181**
13.1 Quillback—*Carpiodes cyprinus* (Lesueur) **185**
13.2 Longnose sucker—*Catostomus catostomus* (Forster) **189**
13.3 White sucker—*Catostomus commersoni* (Lacepède) **193**
13.4 Largescale sucker—*Catostomus macrocheilus* Girard **197**
13.5 Mountain sucker—*Catostomus platyrhynchus* (Cope) **200**
13.6 Silver redhorse—*Moxostoma anisurum* (Rafinesque) **204**
13.7 Shorthead redhorse—*Moxostoma macrolepidotum* (Lesueur) **207**

14 Bullhead Catfish Family—Ictaluridae 211
14.1 Stonecat—*Noturus flavus* Rafinesque 213

15 Pike Family—Esocidae 217
15.1 Northern pike—*Esox lucius* Linnaeus 218

16 Trout Family—Salmonidae 223
Key to the 15 Species 224
16.1 Cisco—*Coregonus artedi* Lesueur 231
16.2 Shortjaw cisco—*Coregonus zenithicus* (Jordan and Evermann) 235
16.3 Lake whitefish—*Coregonus clupeaformis* (Mitchill) 237
16.4 Pygmy whitefish—*Prosopium coulteri* (Eigenmann and Eigenmann) 243
16.5 Round whitefish—*Prosopium cylindraceum* (Pallas) 246
16.6 Mountain whitefish—*Prosopium williamsoni* (Girard) 248
16.7 Arctic grayling—*Thymallus arcticus* (Pallas) 253
16.8 Cutthroat trout—*Oncorhynchus clarki* (Richardson) 257
16.9 Rainbow trout—*Oncorhynchus mykiss* (Walbaum) 263
16.10 Golden trout—*Oncorhynchus aguabonita* (Jordan) 272
16.11 Brown trout—*Salmo trutta* Linnaeus 274
16.12 Bull trout—*Salvelinus confluentus* (Suckley) 279
16.13 Northern Dolly Varden—*Salvelinus malma malma* (Walbaum) 284
16.14 Brook trout—*Salvelinus fontinalis* (Mitchill) 287
16.15 Lake trout—*Salvelinus namaycush* (Walbaum) 291

17 Trout-perch Family—Percopsidae 297
17.1 Trout-perch—*Percopsis omiscomaycus* (Walbaum) 298

18 Cod Family—Gadidae 303
18.1 Burbot—*Lota lota* (Linnaeus) 304

19 **Livebearer Family—Poeciliidae** 309
Key to the 2 Species 310
19.1 Western mosquitofish—*Gambusia affinis* (Baird and Girard) 311
19.2 Sailfin molly—*Poecilia latipinna* (Lesueur) 314

20 **Stickleback Family—Gasterosteidae** 317
Key to the 3 Species 318
20.1 Brook stickleback—*Culaea inconstans* (Kirtland) 319
20.2 Ninespine stickleback—*Pungitius pungitius* (Linnaeus) 324
20.3 Threespine stickleback—*Gasterosteus aculeatus* Linnaeus 328

21 **Sculpin Family—Cottidae** 331
Key to the 4 Species 332
21.1 Slimy sculpin—*Cottus cognatus* Richardson 334
21.2 Shorthead sculpin—*Cottus confusus* Bailey and Bond 338
21.3 Spoonhead sculpin—*Cottus ricei* (Nelson) 342
21.4 Deepwater sculpin—*Myoxocephalus thompsoni* (Girard) 346

22 **Perch Family—Percidae** 349
Key to the 5 Species 349
22.1 Iowa darter—*Etheostoma exile* (Girard) 352
22.2 Logperch—*Percina caprodes* (Rafinesque) 355
22.3 Yellow perch—*Perca flavescens* (Mitchill) 357
22.4 Sauger—*Stizostedion canadense* (Smith) 362
22.5 Walleye—*Stizostedion vitreum vitreum* (Mitchill) 366

23 **Cichlid Family—Cichlidae** 371
23.1 African jewelfish—*Hemichromis bimaculatus* Gill 372

Appendix I—Species Introduced or Collected in Alberta But Not Known to Be Established and Species Found in Adjacent Areas 375
Sturgeon family—Acipenseridae 375
Gar family—Lepisosteidae 375

Freshwater eel family—Anguillidae **376**
Minnow family—Cyprinidae **376**
Trout family—Salmonidae **379**
Livebearer family—Poeciliidae **382**
Sculpin family—Cottidae **382**
Sunfish family—Centrarchidae **383**
Perch family—Percidae **385**
Drum family—Sciaenidae **385**
Cichlid family—Cichlidae **385**

Appendix II—Features of Some Alberta Lakes **387**
Appendix III—Discharge of Major Alberta Rivers **391**
Appendix IV—Metric and Imperial Unit Conversions **395**
Glossary **397**
References **409**
Index to Common and Scientific Names **433**

Preface

A GREAT DEAL HAS been learned about Alberta fishes since the first edition of *The Fishes of Alberta* appeared in 1970. In presenting some of the details on what is known, we have tried to make this book useful and interesting to the layperson, fishermen, and scientist, as well as for students of biology. To attempt to strike a balance for a very diverse audience is not an easy task, but it is hoped that this objective has been at least partially achieved. Much more information on Alberta fishes is available than is presented here in such places as government files and consulting reports (and, unfortunately, many individuals have, no doubt, made valuable but unrecorded observations). This is not to suggest that we now know a great deal about our fishes; many important gaps exist in the knowledge of all our species. This book brings together as much of the present knowledge of our fish fauna as is considered practical. Much of the published information of other workers and of our own is included along with observations on the part of the authors and of many other individuals.

If we are to ensure the longterm survival of the species and their populations comprising our fish resources then we must at least know when and why we have made changes to our fish fauna. Ideally, we should have an ongoing detailed inventory of the species in our rivers and lakes. In this way we can anticipate and document change; all too often we have a presumed change but lack the baseline data necessary to accurately know what was there. This book provides information to identify all fish species known from Alberta and gives general information on where they occur. Experience has shown that even anglers and professional biologists frequently mis-identify our fishes. In written reports this may be analogous to a consumer product testing firm

giving the results for a car but falsely identifying the make. We encourage all persons involved in identifying fish, whether for size records, inventory studies, bioassay research, life-history work, or for sheer enjoyment, to carefully ensure that accurate identifications are made. In appropriate cases, voucher specimens should be deposited in a recognized teaching/research museum with adequate resources to give accurate identification and long-term care such as at the University of Alberta Museum of Zoology (UAMZ). This material is then available for further study.

This book is divided into a number of chapters. Before describing each species, we discuss a number of topics pertaining to special aspects of our fishes and discuss subjects that allow the reader to better appreciate our fishes and to better understand the species accounts. After these general subjects we present a key allowing the reader to identify any specimen to one of the 15 families found in Alberta, then we discuss the species. Keys to the species are found in the introductory section of each family for those families with more than one species in Alberta. The use of keys is explained in Chapter 7, Section 7.2.

Each species has the following information given for it. The common name and the scientific name with its translated meaning are first given followed by a picture. Next, there is a descriptive section; its purpose is to provide enough information to ensure the correct identification of a species as well as to provide information on the general characteristics of each species. Information under "Description" is given under several headings. "Color" and "Body" information is generally based on specimens from Alberta, usually deposited in the University of Alberta Museum of Zoology, except that counts of body parts usually include data on variation from throughout the range of the species. The descriptive comments under "Body" includes the head and what is anatomically regarded as the trunk and tail (the term "body" is variously used in the literature to include the head or to include only the trunk and tail). "Size" is the maximum known size of the species. Counts of certain body parts, including number of vertebrae as obtained from radiographs (X-rays), have been made on specimens from Alberta on all but a few of our species. This information is given after the general description under the heading "Alberta." The radiographs are deposited at the UAMZ.

The heading "Alberta" also gives the maximum known size of an individual obtained in Alberta. For nongame species it is usually based on UAMZ material. Some Alberta size records for game species have

been taken from Scammell (1990). Other sources listing records are the 1986 publication of the Alberta Fish and Game Association (Edmonton) "Alberta Wildlife Trophies" and regulations of the Alberta Fish and Wildlife Division. As alluded to in Scammell (1990), there have been problems in establishing valid size records of game species in Alberta. Problems have existed and seem to continue to exist on the accuracy of information on identification of the species, length, weight, and location. Evidence has not always been accepted as critically as it would be in a court case. For differences in meaning of the word length as applied to a fish the reader is referred to the terms "fork length," "standard length," and "total length" in Chapter 7, Section 7.3.

The "Distribution" section gives a general indication of the species world-wide occurrence and then a brief summary statement of the Alberta range. A statement on data used in making the distribution maps is given in Chapter 7, Section 7.1.

The "Biology" section gives general information on the life history of our fishes and on other aspects of their biology. Specific reference to certain findings in Alberta are included.

A section on "Angling" is given for the game fishes. Almost any species that will bite a hook can provide recreation for anglers but we include this section only for those species more conventionally sought after by anglers.

The "Historical Note" section tells who first described the species, when, and from where. It then indicates when the species was first described from Alberta, and often gives other information of an historical or taxonomic nature.

We have accepted some unpublished information as personal communication; of course, only reliable sources have been employed for these contributions. We have not attempted to give a review of what is known on the biology of our species stemming from studies made throughout their range. Such a review of the literature would greatly enlarge the book. Information in such reviews is of immense interest to government and consulting biologists and individuals are often hired to prepare such material. The book is thus not intended, nor was the first edition, to be a reference manual for the professional biologist seeking a broad review of the literature. Readers seeking further information on our species should consult larger regional works such as Scott and Crossman (1973), various COSEWIC reports as published in the Canadian Field-Naturalist, and the many bibliographic aids to the

literature such as Victor Cvancara's annually produced "Current references in fish research."

We hope that novice users of this book will enjoy studying the fishes that occur in Alberta, and we hope that this book will stimulate or reinforce an interest in making fish a part of their natural history observations. Finally, we hope that the experienced users will also find this a good source of information.

Joseph S. Nelson and Martin J. Paetz
Edmonton, Alberta
January 1992

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Introduction

ALBERTA HAS A DIVERSE fish fauna. There are 51 native species and eight introduced ones; about 17 species are sought after by anglers. There are representatives of 13 families native to the province, ranging from the primitive jawless lamprey to advanced spiny-rayed members of the perch family and from the coldwater trout and char to the coolwater sturgeon and goldeye. Species of two other families have been introduced and have reproducing populations in a hotspring. As knowledge about our fishes expands, a few more native species may be identified. For example, one specimen of the prickly sculpin was taken from the Peace River in 1989 and this species, well-known in British Columbia, may be established in the Alberta portion of this river. In all, then, there are 59 species with reproducing populations that are presently known to occur in Alberta. If prickly sculpin and introduced smallmouth bass, which may or may not be self-sustaining, are included we have 61 species that are presently found in the province. Several other species have been introduced but no longer occur here, and a few exotics may be found in restricted areas (see Appendix 1).

All the fish in Alberta are "freshwater" species that spend their entire life in fresh water throughout the province. However, a few species found in Alberta, such as rainbow, brook, and brown trout and ninespine stickleback, have populations outside Alberta that are anadromous. Anadromous fish are ones that must spawn in fresh water but spend part of their life in the ocean. There are no anadromous fish populations in Alberta, and if there were they would exist only in the Slave River system because natural and man-made barriers on other rivers would prevent their return to this province. However, some of our fish live in lakes that are not strictly speaking "fresh" water. These

Main highways, cities, towns, lakes, and rivers in the province of Alberta.

lakes range from slightly saline or higher; that is, they have over 500 milligrams per liter (mg/L) or parts per million (ppm) total dissolved solids. Most such lakes are still less saline than ocean water (generally 34,000-36,000 mg/L or ppm). Most species of freshwater fish have difficulty surviving or reproducing in water more saline than 5,000 mg/L. The term "inland waters" is sometimes used instead of "fresh water" to include lakes and streams that may be to some extent saline. We use the term "fresh water" for all our lakes and streams regardless of their salinity.

The Province of Alberta has a diversity of lakes and streams. Numerous bodies of water which offer excellent fishing opportunities exist on the plains and in the mountains. Alberta is situated on the easterly sloping height of land in western Canada between the 49th and 60th parallels of north latitude. The 1217 kilometer (km) long eastern boundary is located at 110° west longitude and the western boundary is marked by 120° west longitude in the northern portion and the continental divide in the southern portion. In all, 16,796 square kilometers (km^2) of Alberta is water, but this is only 2.5% of the province's area of 661,188 km^2. The province contributes only about 2.2% of Canada's inland water surface.

Factors such as topography, climate, vegetative cover, and geological history profoundly influence the distribution of fish species in inland waters. It is thus useful to consider some of the features which characterize the province. Included within the province are three main physiographic regions; the rugged Cordillera in the southwest, the great plains which occupy the majority of the area in the north-west to south-east direction, and the Canadian Shield in the extreme north-east corner. Alberta is the only Canadian province which contains a portion of each of these three regions. From altitudes of up to 3747 meters (m) in the Rocky Mountains (Mt.Columbia), the land surface slopes, abruptly at first then more gently, in easterly and north-easterly directions. The lowest elevation of about 182 m above sea level is found in the north-east corner near Fort Smith where the Slave and Salt rivers cross the Alberta-Northwest Territories border.

A combination of climate and topography have produced four distinct vegetative zones. The Boreal Region, including the Canadian Shield, is forested land that is dominated by spruce, fir, pine, larch, poplar, and birch. It occupies most of the northern half of the province as well as a relatively narrow band along the eastern slopes of the mountains, termed the foothills, extending south to the Bow River west of

Altitude map of Alberta.

Cochrane (but excluding the Bow Valley itself) and further south to near Turner Valley. The Boreal Region comprises almost two-thirds of the province's land area. To the south and east of the forested area lies a transition zone or Parkland Region characterized by moderate to gently rolling topography and groves of trembling aspen alternating with prairie. Except for isolated northern patches, it extends from slightly north of Edmonton to as far south as the Alberta-Montana border in a narrow patchy strip along the foothills. To the east of the foothills, this zone gives way to the Prairie or Grasslands Region in the vicinity of a line between Airdrie and Coronation. From here the semi-arid prairies extend south to the International border. The fourth major region, the Rocky Mountains, extends along the entire southwestern border with British Columbia from near Grande Cache to Waterton Lakes National Park. The Rocky Mountains play a role in influencing fish distribution, both as a barrier and in providing clean rocky-bottom aquatic habitat. Some areas, such as the Cypress Hills in southeastern Alberta, include two or more of these regions.

The province is drained by nine river systems. Most of our water, about 86.4%, is carried by the Hay, Peace, and Athabasca rivers in northerly and north-easterly directions and eventually reaches the Arctic Ocean by way of the Mackenzie River. The Peace River, which originates in British Columbia, joins with water flowing out of Lake Athabasca, whose major tributary is the Athabasca River, to form the short but large Slave River. The Slave River and several other rivers to the west, considered here as part of the Slave River Basin, flow into Great Slave Lake as does the Hay River. The small Petitot system including Bistcho Lake drains westerly into the Liard basin, and thence into the Mackenzie. The majority of the region traversed by these drainage systems is forested land. The Beaver (Churchill system), North Saskatchewan (including the Battle), and South Saskatchewan river systems (including the Red Deer, Bow, and Oldman rivers) drain the central and most of the southern parts of the province and flow eastward to form part of the Hudson Bay drainage via the Churchill and Nelson rivers. The extreme southern part of the province is drained by the Milk River whose waters enter the Gulf of Mexico via the Missouri and Mississippi rivers. The total length of flowing water in the province, excluding intermittent streams, has been estimated to be between 19,300 and 20,900 km. While the total area of about 16,800 km^2 covered by water in the province may seem to be considerable, it is less than that of all the other provinces except for the three in the Maritimes and

Major drainage basins of Alberta.

Major rivers of western Canada and the adjacent United States.

is very small compared to the 183,890 km² of water contained in the province of Quebec. Also, in contrast to Alberta, about 15.6% of Manitoba is comprised of fresh water.

The largest lake completely within Alberta is Lesser Slave Lake with a surface area of almost 1200 km² (that portion of Lake Athabasca extending into Alberta is approximately 2,300 km² while the whole lake is almost 7,800 km²). Lesser Slave Lake is, however, relatively small compared to the largest lakes in the neighboring provinces and only 3.7% the area of the largest lake entirely within Canada—Great Bear Lake. The deepest lake in Alberta is Waterton Lake which has a maximum depth of 135 m, but again by comparison it is not as deep as many lakes in British Columbia and only about 8% as deep as the world's deepest lake—Lake Baikal in southeastern Siberia. The river with the largest discharge in Alberta is the Slave River which is greater than the Fraser

River but only about 1.7% that of the world's largest river, the Amazon.

Despite the diversity of the aquatic habitat and the area of the province, the number of fish species in Alberta is relatively low. Many inland states in the United States that are much smaller in area than Alberta, such as Indiana and Ohio, have several times as many native species. What there is in the province is thus very valuable and worthy of protection and enjoyment. Many of our 59 species of fish can be seen by the patient observer along stream banks or lake shorelines. Some are especially interesting to watch while they are on spawning migrations (e.g., suckers) or while spawning (e.g., suckers, fathead minnow, sticklebacks, and brown trout). Others can be studied in the hand when caught while fishing. Evidence of some fish may be apparent when they rise to feed on insects or when they are being eaten by birds or mammals. One can observe the behavior of three introduced tropical fish from the convenience of a boardwalk with interpretative signs established by Parks Canada at the Cave and Basin near Banff townsite; these fishes and other animals and green aquatic plants can be observed at this hotsprings site even in the depth of winter. Apart from this, an exciting opportunity for observing virtually all our species exists while snorkelling or scuba diving. All our fishes, even those never seen by the general public, can still be appreciated by learning something about them, and knowing that they exist.

I Alberta's Fishes

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1 Fishing in Alberta

THE FISH RESOURCES OF Alberta are used by four groups of people: commercial fishermen, domestic fishermen, sport fishermen, and members of the general public who are interested in seeing fish and knowing that they are an important part of our natural environment. The following discussion deals with the three fisheries.

The commercial gill-net fishery, beginning around the turn of the twentieth century, has traditionally harvested six fish species. Lake whitefish, lake trout, walleye, pike, cisco, and, to a lesser extent, yellow perch, have made up the bulk of the catch over the years. Goldeye were briefly harvested in lakes of the Athabasca delta in the 1960s, but this species did not make a significant contribution to the fishery. In the past fifty years approximately 100 lakes have been fished commercially with total production varying between 1.2 million kilograms (kg) and 7.6 million kg per year. Peak yields occurred in the late 1950s and early 1960s. Following these high yield years there was a general decline until harvests stabilized at a level of 1 to 1.5 million kg per year. There are two commercial seasons, an open water season and a winter season; in the latter the gill nets are set under the ice with a device called the ice-jigger.

Likely factors in the decline in commercial yield have been the rapid growth of the sport fishery which has claimed much of the lake trout, pike, walleye, and, to some extent, the lake whitefish production, and a dramatic reduction in the harvest of cisco which were formerly used extensively as animal food by the mink ranching industry.

The number of fishermen involved in the industry has ranged from about 600 in the early 1930s to slightly over 8,000 in 1957-58. Currently, about 2,300 fishermen are involved.

The landed value of commercially caught fish is dependent on market conditions. Recently, the annual value has been about 2.8-3.1 million dollars, but it has frequently been in the one million dollar range. The majority of the catch (75-80%) is exported to the United States in the fresh dressed form.

The domestic fishery—also a gill-net fishery—is carried on by treaty Indians and other residents in remote areas of northern Alberta who require fish for sustenance for themselves or their dogs. It is estimated that the annual harvest by domestic gill nets is in excess of 500,000 kg annually.

The angling or sport fishery has become the largest segment of the fishery both in terms of numbers of fish harvested and in numbers of people involved (and, of course, in revenues generated). Recent estimates indicate that approximately 400,000 Albertans each fish an average of about 18 days per year. In addition, a modest number of anglers from other parts of Canada and from other countries fish in Alberta. Anglers may catch an estimated 19 million fish of all species per year and retain some 11 million of them (or 7 million kilograms). The most frequently caught species are, respectively, yellow perch, northern pike, trout (in general), and walleye. As well, our anglers have a preference for the various game fish in the following order: trout (in general), walleye, northern pike, yellow perch, lake whitefish, Arctic grayling, mountain whitefish, goldeye, and then others. Additional information may be found in a report of the federal Department of Fisheries and Oceans (1988).

While the open water season is generally thought of as the time for fishing there is also a substantial sports fishery in the winter months (see Macpherson 1985 for a discussion of this). As an aside, many people wonder if fish experience pain when caught. There is no easy answer to this question, but in an article published in the first issue of the German journal "Fischökologie," Klausewitz (1989) states that physical pain caused by a hook or by being confined in a net appears to be less severe than chemically induced "pain" caused by the stress that may occur when a fish is caught.

Given the enthusiasm that Alberta residents have in the sport of fishing, it is of interest to examine the angling opportunities that lie within our borders. To do so, it is convenient to discuss the sport fishery as it exists in each of the major drainage basins of the province proceeding from south to north.

1.1 The Milk River System

For the most part, the Milk River, an east-slope plains stream, is considered borderline coolwater to warmwater habitat and its principal sport fish is the sauger. Angling for sauger is generally good with fish over 1 kg being common. The sauger is probably better known for its eating qualities than for its sporting qualities. Although rainbow trout and cutthroat trout are present in the upper reaches of the Milk River, stream fishing opportunities for these trout are limited by lack of coldwater habitat.

Lakes that produce fish are scarce within this basin. Shanks Lake near the Alberta-Montana border provides moderate angling opportunities for northern pike.

1.2 The South Saskatchewan River System

The South Saskatchewan basin contains four sub-basins and covers 18% of the land area of Alberta. The Red Deer, Bow, Oldman, and the South Saskatchewan proper are the important drainage areas of the system. In total, this system includes about 5,000 km of flowing water, somewhat over half of which is suitable for the production of salmonid fishes. The basin contains the province's most productive trout streams and offers numerous exciting angling possibilities.

In streams of the Oldman River system, rainbow, cutthroat, brown, brook, and bull trout and mountain whitefish are present with the native mountain whitefish and cutthroat and introduced rainbow providing a large part of the angling activity. In general terms, trout growth in the Oldman river system is better than in most other streams located further north along the eastern slopes. Noteworthy among the streams of the system are the mainstem of the Oldman River from Pincher Station to the headwaters. Very good rainbow trout fishing is found in the middle and lower reaches while cutthroat and bull trout fishing takes place in the upper reaches. The Castle River similarly supplies rainbow trout fishing in lower reaches and fine cutthroat fishing in middle and upper sections. One of the most important success stories in this system, however, is the Crowsnest River. This excellent trout stream rises in Crowsnest Lake near the B.C.-Alberta border and courses eastward through mountains and foothills to join the Oldman River near Cowley. Historically, the Crowsnest River has not always had the reputation of being a good trout stream. During the period of active coal

Angler releasing a rainbow trout from the Crowsnest River. Photo courtesy of V. Bergman.

mining in the Crowsnest Pass area this stream was subject to severe pollution from the waste coal products which were strewn along its banks and much of which found its way into the stream. As a result its productivity and aesthetics as a fishing stream were much impaired. After the period of active coal mining in the valley was over (20 to 15 years ago) and after rehabilitation of many of the huge mounds of waste coal was undertaken, the river began to show a dramatic recovery. Enrichment from wastewater treatment plants in the Crowsnest Pass has further enhanced production to the point where the river is now the most productive trout stream in southwestern Alberta. It is primarily known for its rainbow and brown trout and mountain whitefish fisheries. Recent construction of the Three Rivers Dam on the Oldman River upstream from Fort McLeod, however, has flooded the lower several kilometers of the Crowsnest River thereby removing one of the more productive sections of the stream. Efforts to mitigate this loss to the sport fishery are being undertaken on the river above the dam through habitat improvement structures.

While the upper Oldman River is generally characterized by cold-water habitat, there is a transition zone near Fort McLeod where the river changes and provides coolwater habitat. The lower reaches of the

Oldman River, namely the transition zone and the coolwater parts, provide habitat for such game fish as goldeye, walleye, sauger, and northern pike. There may be changes in the thermal regime of the lower Oldman River as a result of the Three Rivers Dam; however, we are uncertain about the extent of these changes.

The South Saskatchewan River is formed by the confluence of the Bow and Oldman rivers. It is a large coolwater stream with a game fish population similar to that of the lower Oldman River. In addition, however, the presence of lake sturgeon provides a new experience in river fishing. Sturgeon grow larger than other Alberta sport fish and exceptional specimens in the South Saskatchewan River may weigh as much as 45 kg. Lake whitefish have been introduced into some of the plains rivers through irrigation canals.

The Bow River system offers a variety of fishing opportunities from coldwater angling in small upper tributaries containing mainly cutthroat trout to superb angling for large rainbow and brown trout in the middle reaches and finally in the lower reaches with its coolwater fishery for goldeye, walleye, pike, and sauger. The fame of the Bow River as a trout fishery from Calgary downstream to the Blackfoot Indian Reserve has spread throughout the world. Nutrients added by the City of Calgary along with moderate water temperatures and controlled flows transform the river from a cold, relatively unproductive environment to a highly productive one which is truly a trout fisherman's delight. Special fishing regulations have been developed for the Bow River from Calgary to the Blackfoot Reserve in order to maintain a high quality angling fishery.

The Red Deer River system accounts for slightly more than 40% of the South Saskatchewan basin. The mainstem of the river from the Dickson area upstream is probably best known as a mountain whitefish sport fishery although some brown trout, rainbow trout, brook trout, and bull trout are present to challenge the more dedicated angler. Noteable among the Red Deer tributaries are the Raven River and its branch, the North Raven. These brown trout streams have their sources in large springs which maintain fairly uniform flows and excellent stream temperatures for salmonids. A very substantial stream bank protection program is being carried out on these two rivers in order to preserve the aquatic habitat and maintain the high quality of their fisheries. There is a transition zone from Gleniffer Lake (the reservoir impounded by the Dickson Dam) to the city of Red Deer with much diversity in the species of fishes (i.e., there is a mixture of coldwater

foothills and coolwater plains species). The lower reaches of the Red Deer mainstream (Red Deer to the Saskatchewan border) provide habitat for pike, walleye, sauger, goldeye, and mooneye. Goldeye fishing has been particularly rewarding in this part of the river.

Lake fishing opportunities in the South Saskatchewan basin are limited by a combination of geography and climate. A number of small high altitude lakes in the headwater areas of the various drainage systems supply good wilderness type fishing for cutthroat trout and to a lesser extent for the introduced golden trout and brook trout. South Fork, Blue, Rainy Ridge, Carnarvon, Rawson, and Three Isle lakes are a few examples. Within the prairie regions of the drainage system, a number of irrigation reservoirs, i.e., Lake Newell, Sherburne Reservoir, Chestermere Lake, and Milk River Ridge Reservoir provide good fishing mainly for pike and lake whitefish. Pike appear to be the main target of anglers with individuals as large as 14 kg being caught occasionally. When the off-stream reservoirs are newly constructed and stocked with trout, however, they often provide spectacular trout fisheries for a few years. Sherburne Reservoir near Lethbridge was an example in the 1950s, and in the 1980s Crawling Valley Reservoir near Bassano provided an extremely attractive rainbow trout fishery. As the reservoirs age, other species (lake whitefish, pike) predominate and trout are caught only incidentally unless they are annually stocked. On some of these reservoirs a commercial fishery for lake whitefish has developed.

1.3 The North Saskatchewan River System

The North Saskatchewan system includes the drainage basins of the Ram, Clearwater, Brazeau, and Battle rivers. Of an estimated 3,600 km of stream in the entire basin, approximately one-half is suitable for trout and other coldwater fishes. The coldwater habitat is mainly located above the junction of the Clearwater and North Saskatchewan rivers and in the upper half of the Brazeau drainage. Below this, the river gradually becomes warmer and the game fish community shifts toward walleye, pike, goldeye, mooneye, and sauger. These species are dominant throughout these lower reaches of the system although a limited population of lake sturgeon is also present in the vicinity of Edmonton and downstream.

The upper mainstem of the North Saskatchewan and its tributaries are mostly cold swift streams with limited sport fishing potential. Recent

introductions of cutthroat trout in the Bighorn River may, however, improve angling prospects. Below Nordegg, Shunda Creek and Trout Creek have more moderate velocities and have long been known to anglers for their brown trout fishing.

Proceeding downstream, the Ram River system is of particular interest because its cutthroat trout population has developed from a stocking made in 1955. Prior to that, no game fish were present due to an impassible set of falls several kilometers above the mouth of the main stem of the Ram. The introduction of cutthroat trout has resulted in most streams in the Ram River system offering good trout fishing. The lack of competing species of both game and non-game fishes has no doubt been of considerable benefit to the cutthroat in this system as well as making the drainage unique among eastern slope streams of comparable size and extent.

The Clearwater River is similar in many respects to the upper mainstem of the North Saskatchewan. Sport fishing is mainly for mountain whitefish, bull trout, and, in lower reaches, brown trout. One of its more gentle tributaries, Elk Creek, provides fishing opportunities for brown trout. Best known among the Clearwater tributaries, however, is the Prairie Creek system which offers good brook trout, brown trout, and mountain whitefish fishing.

The Brazeau River supports bull trout and mountain whitefish. Much of the river above Brazeau Reservoir is inaccessible except by all-terrain vehicle or by horseback. The recent introduction of cutthroat trout in some of the tributaries of the Nordegg River may provide additional sport fishing opportunities.

The Battle River consists of a meandering channel through parkland and prairie regions of central and eastern Alberta. Low flows during the winter tend to limit the sport fishery potential of this river, but pike, walleye, and goldeye are available in the middle and lower reaches. In the spring and early summer some walleye of exceptional size can be caught from Forestburg Reservoir downstream to the North Saskatchewan River.

Lakes are not plentiful in the North Saskatchewan River basin, hence lake fishing opportunities are somewhat limited. Swan Lake near Caroline has a native population of lake trout. The stocking of small headwater mountain lakes with cutthroat trout has provided that part of the system with some good wilderness angling opportunities; Lake of the Falls and Landslide Lake are examples. Examples of lakes in the moderate and lower elevations that provide good to excellent rainbow

trout fishing through stocking are as follows: i) Fish Lake, near Nordegg, ii) Strubel and Cow lakes near Rocky Mountain House, iii) Hasse, Star, and Spring lakes near Edmonton, and iv) Jackfish, Shuster, and Dilberry lakes in the eastern part of the basin. Numerous other 'pothole-type' lakes in the central part of the basin provide additional opportunities for rainbow trout fishing. The larger coolwater lakes are primarily producers of pike, perch, lake whitefish, and, in some cases, walleye. Prominent among these are Buck Lake, Wabamun Lake, Pigeon Lake, Lake Isle, Lac Ste. Anne, and Battle Lake. Sport fishing for lake whitefish, though practically unknown in Alberta prior to the 1950s, has become a very popular form of late fall and winter recreation especially on Wabamun Lake, Pigeon Lake, and Lac Ste. Anne.

1.4 The Athabasca River System

The Athabasca River basin contains an estimated 5,830 km of streams, about 40% of which can be classed as coldwater fish habitat or 'trout' water. The main components of this large drainage are the Pembina, McLeod, Berland, Lesser Slave, La Biche, and Clearwater river systems, but a host of smaller primary tributaries join the Athabasca mainstream along its route from its headwaters in Jasper National Park to Lake Athabasca in the far northeastern part of the province. Most of the trout streams in the Athabasca system lie upstream from the entry of the McLeod River and in the headwaters of the Sakwatamau and Freeman rivers on the southeast slopes of the Swan Hills; however, Arctic grayling are common in the small and medium sized streams throughout the basin. The upper mainstem of the Athabasca River is relatively unproductive as a trout fishery but is noted for the large mountain whitefish (up to 2 kg) which are caught near the entry of such rivers as the Maligne, Berland, Oldman, and McLeod. Below the McLeod River junction, the Athabasca River is considered coolwater habitat with the main sportfish species being pike, walleye, goldeye, and lake whitefish. Again, the best angling occurs near the junction of larger tributaries such as the Freeman, Pembina, Lesser Slave, Calling, La Biche, and Clearwater rivers. Large walleye (5 to 6 kg) are taken at these locations. The Athabasca River divides into channels to form a delta prior to entering Lake Athabasca, and this area has become well known as a producer of large pike. Access to this area, however, is limited to boats and aircraft.

Streams of the Berland River system which are generally considered to be fair to good coldwater fisheries are the Berland mainstem and

the Wildhay River. Rainbow trout, Arctic grayling, and mountain whitefish provide the main angling opportunities but bull trout and brook trout are also available in the system.

The McLeod River and its tributaries have been popular angling streams since the early 1900s, when coal mines were developed near the headwaters. Small native rainbow trout typical of many streams in the upper Athabasca drainage, along with mountain whitefish and bull trout, have provided the bulk of the angling. Arctic grayling also supply good fishing in the McLeod mainstem near Edson and in tributaries north and west of this center. Some of the streams that have been recognized as productive fisheries are the Edson River in upper reaches, Trout Creek, Sundance Creek, MacKenzie Creek, and the McLeod mainstem.

The Pembina River drains an area from the mountains southwest of Edson to Flatbush. In colder upper reaches mountain whitefish are the most abundant game fish while Arctic grayling appear to be a declining species in some tributaries. The middle and lower reaches of the Pembina provide good to very good fishing for walleye, goldeye, and pike.

The Lesser Slave River basin includes a large number of tributaries to Lesser Slave Lake, several of which have populations of Arctic grayling. Noteable are the upper Swan River and its tributaries, Moosehorn, and Inverness creeks. The upper Driftpile River, Marten Creek, and the Fawcett River also offer grayling fishing; however, recent road and oil field development have put a great deal of pressure on this species. The mainstem of the Lesser Slave River is primarily a pike and walleye stream.

Tributary streams of the Athabasca River between Athabasca and Fort McMurray generally have poor access and are not well known. The Calling River (pike and walleye) and the House River (Arctic grayling) provide the best sport fishing opportunities.

The Clearwater River basin supports many stream fisheries. Best known are Christina and Winefred rivers where Arctic grayling, walleye, and pike are regularly caught. The Hangingstone River is also a grayling stream as are the May and Goose rivers. The Clearwater mainstem is a large river, reaching far into neighboring Saskatchewan. The Alberta portion is fished extensively for pike and walleye.

Several good Arctic grayling streams enter the Athabasca River from Fort McMurray to the Athabasca Delta. The Steepbank, the upper Ells, and upper Firebag rivers have worthy reputations. Access to these streams is very limited, however.

Lakes are abundant in the Athabasca basin, especially in the lower half. They range in size from Lesser Slave Lake with 1,200 km² to small mountain lakes with areas of only a few hectares. Approximately 50 lakes in the basin are stocked either annually or periodically with trout, mainly rainbow and brook trout, but occasional stockings of brown trout and Arctic grayling have been made. In the mountainous area the better known angling lakes are Maligne, Pyramid, Patricia, Amethyst, Beaver, Celestine, Edith, Dragon, Christine, and Rock lakes. Pyramid and Rock lakes are notable for their lake trout populations. Throughout the remainder of the basin some of the better trout fishing opportunities are found in Emerson, Wildhorse, McLeod, Lower Chain, Dolberg, Christina, and Edith lakes but a number of other stocked lakes are also good rainbow or brook trout fisheries. At the lower end of the Athabasca system two lakes which are fished for native lake trout are Namur and Grist lakes.

Many lakes provide pike, perch, lake whitefish and/or walleye fishing. Some lakes popular with fishermen are as follows: Lesser Slave Lake (pike and walleye); Calling Lake (pike and walleye); Gregoire Lake (walleye); Gypsy Lake (pike); Christina Lake (pike and walleye); Heart, Jackson, Kinnaird, and Blackett lakes (perch and walleye); Fawcett, Rock Island, and Orloff lakes (pike and walleye); and Baptiste Lake and Lac La Nonne (pike, perch, and walleye). Space does not permit discussion of the many other bodies of waters which are visited for pike, perch, and walleye fishing throughout this river system, but it is estimated that there are 60 to 70 such lakes. Of particular interest, however, are several which have been declared "trophy lakes" because of their capability to produce larger than average pike, lake trout, or walleye. Special regulations designed to maintain the production of large fish are in effect on these lakes including the requirement for anglers to have a trophy lake licence. Designated trophy lakes in the Athabasca River basin are Winefred, Gardiner, and Namur lakes. In the former two, walleye in excess of 3 kg and pike over 9 kg have been frequently recorded. In Namur Lake, lake trout over 9 kg were taken by fishermen when the lake was identified as a trophy lake.

1.5 The Beaver River System

The Beaver River system is one of the smaller drainage basins in Alberta. Located in east central Alberta, it forms part of the headwater system of the Churchill River. The entire 240 km of stream length which makes up the system in Alberta is considered coolwater (versus coldwater)

habitat because most of the source of the river is the relatively warm surface water of a number of lakes in the basin. Pike and walleye provide fair to good angling in the Beaver River mainstem and primary tributaries such as the Sand and Moose Lake rivers. It is noteworthy that this drainage supports the only native population of freshwater crayfish, *Orconectes virilis*, found in the province.

The Beaver River system has a generous supply of attractive fishing lakes. Perch, pike, walleye, and, to a lesser extent, lake whitefish provide the bulk of the angling. Seibert and May lakes are assigned trophy lake status and the large northern pike found there offer plenty of challenge to anglers. Two highly productive and popular lakes are Moose Lake and Kehiwin Lake; both are known for good walleye and perch populations. In the extreme western part of the basin, anglers have a choice of a number of fairly large lakes; Beaver, Elinor, Helena, Touchwood, Spencer, Seibert, Pinehurst, Ironwood, and Fork lakes all provide better-than-average fishing for pike and perch and all but Fork Lake also have walleye. Further to the east are Wolf, Tucker, Bourque, Moore, Hilda, Ethel, and Marie lakes. Of these, Wolf, Ethel, and Moore lakes probably have the best reputations as fisheries.

Cold Lake, on the Alberta-Saskatchewan border, in addition to offering pike and walleye fishing, is better known for its lake trout angling. A fish hatchery has recently been established on the west shore of the lake to assist in maintaining walleye and lake trout fisheries in Alberta.

1.6 The Peace River System

The Peace River basin drains about 29% of the land area of the province and is the largest of the several drainage areas in terms of linear stream distance and water volume. About one-third of its 5,830 km of flowing water is considered to be coldwater habitat. Most of this coldwater environment is found in the middle and upper reaches of the Smoky River, Wapiti River, Simonette River, Little Smoky River, and several rivers draining the south slopes of the Caribou mountains. Smaller amounts are found in the Wabasca and Mikkwa River systems. The majority of coldwater stream fishing is supplied by the native species, Arctic grayling, bull trout, and mountain whitefish. There are still opportunities for true wilderness Arctic grayling fishing in some of the more inaccessible parts of the basin. Introduced rainbow, cutthroat, and brook trout have remained limited in distribution to the vicinities of their introduction and, therefore, do not account for a large percentage

of the coldwater stream fishery. The lower reaches of most tributaries as well as the mainstem of the Peace River are generally coolwater environments which support pike, walleye, and/or goldeye populations. As in the case of the Athabasca River, angling in the larger coolwater streams is concentrated near the mouths of tributaries such as the Simonette, Little Smoky, Notikewin, Cadotte, and Wabasca rivers.

The Smoky River system has a good deal of cold fast flowing water so that upper tributaries generally have no productive fisheries. In the foothill regions, however, a number of tributaries have good angling potential. Sheep Creek, Bolton Creek, Kakwa River, and Cutbank River are popular streams for mountain whitefish and Arctic grayling. The Muskeg River drainage also offers opportunities for these species as well as some brook trout, rainbow trout, and bull trout fishing. The Torrens River, site of a cutthroat trout introduction, now provides stream fishing for that species.

The Little Smoky River provides anglers with a wide choice of fishing opportunities. The upper one-third (from Smoke Lake upstream) is generally considered to be a good Arctic grayling and mountain whitefish stream. The lower two-thirds is primarily pike and walleye habitat and has an equally good reputation as a stream fishery for these species. Two tributaries offering additional grayling and mountain whitefish fishing are Waskahigan and Tony creeks.

The primary sport fishing interests in the Wapiti River and its major tributaries are Arctic grayling, mountain whitefish, and bull trout. There are about 110 km of coldwater stream habitat in the Wapiti mainstem upstream from its junction with the Beaverlodge River.

The Wabasca River is a large tributary of the lower Peace River system. The mainstem of the Wabasca is about 570 km in length, all of which is coolwater stream habitat producing pike and walleye. Goldeye are also present in the lower reaches. The stream fishery in the Wabasca River, once accessible only by boat, has now become considerably more available to anglers because of the completion of Highway #67 from Red Earth to Fort Vermilion. The section of the river between North and South Wabasca lakes has been a popular and productive spring walleye fishery for some years.

Coldwater stream habitat is very limited in the Wabasca system; however, two streams, the Willow River and Leige River, offer Arctic grayling fishing. Immediately to the east of the Wabasca basin is the Mikkwa River, an Arctic grayling stream in pristine condition. At present, however, it is accessible only by air or by boat from the Peace River.

Several streams originating in the Caribou Mountains north of Fort Vermilion also offer wilderness fishing conditions for Arctic grayling but like the Mikkwa River, are accessible only by air. These streams are the Ponton, Caribou, Lawrence, and Wentzel rivers.

Lakes vary from scarce in some parts of the Peace River basin to abundant in others such as in the Wabasca sub-basin. Eight lakes have natural lake trout populations. Only one of these, Peerless Lake, has road access and is rated fair to good for lake trout angling. The remaining seven coldwater lakes are found in the Caribou Mountains and are accessible only by air at present. The largest of these is Margaret Lake where a sport fishing lodge is in operation. Lake trout fishing in the Caribou Mountain areas is generally considered to be good although most of the lakes are small and will not sustain heavy use.

Lakes which contain trout species other than lake trout rely mainly on stocking to provide a fishery. Brook trout are found in Adolphus, Beatrix, Smoky, Nose, Figure Eight, Upper Pierre Greys (= #3), and North Two lakes. Rainbow trout fishing is available in Twintree, Grande Cache, Victor, Long, Musreau, Figure Eight, Lower and Middle Pierre Greys (= #1 and #2, respectively), and South Two lakes. Angling success is variable but Upper Pierre Greys, Twintree, and North and South Two lakes may be considered the most promising.

Fishing for coolwater game fish in the Peace system is widespread with the best opportunities occurring in the Little Smoky and Wabasca drainage areas. Pike fishing is good to excellent in Utikima, Graham, Gods, Sturgeon, and Wabasca lakes but this species is also abundant in many other popular waters such as Vandersteen, Wadlin, Haig, Equisetum, Long, and Snipe lakes.

Walleye are less widespread than pike, although good walleye fishing is available in Iosegun, Sturgeon, Vandersteen, Sandy, and Wabasca lakes. Better known lakes for perch fishing are Meekwap, Sturgeon, Utikuma, Goosegrass, and Crooked lakes with the latter being especially recognized for large perch.

1.7 The Precambrian Shield Waters

In the extreme northeast of the province—north of Lake Athabasca and east of the Slave River—there is a portion of the Canadian Shield accessible only by air which consists mainly of Precambrian rock outcrops, rather stunted coniferous forests, and a large number of lakes. There are few streams of any importance to anglers. This region stands out

as the lake trout area of Alberta, boasting more than a dozen medium to large lakes where fishing for lake trout is considered good to excellent. Best known, perhaps, is Andrew Lake which is also classified as a "trophy lake." Other lakes offering good lake trout opportunities are Leland, Tulip, Charles, Colin, Cornwall, Potts, and Wylie lakes. Many smaller lakes in the area offer wilderness class fishing for pike and to a lesser extent for walleye. Bocquene, Ryan, and Loutit lakes are a few examples. A large number of the lakes in the region are as yet unsurveyed as to their fishery potential and may well offer superb fishing opportunities.

2 Fish Management in Alberta

THE MAIN OBJECTIVE OF fish management in the province is to maintain fish stocks at levels that will reasonably meet the needs of anglers, commercial fishermen, and domestic fishermen (native people and others who are granted licences to obtain fish for food). For the most part this has been done by: regulating where, when, and how fish may be caught; regulating the numbers and in some cases the size of the fish that may be kept; and by introducing new species and stocking hatchery raised fish. Recently, however, attention has been turned to the deterioration and loss of fish habitat, and efforts of government agencies and conservationists are being increasingly directed at restoration and/or maintenance of the habitat base.

While fish culture operations have become an established part of fisheries management, there was a dangerous reliance placed upon them by the public during the first half of the century. Unfortunately, people may unwittingly permit the gradual destruction of a wild fish population with its unique genetic composition, believing that hatcheries can easily replace what has been lost in nature. While the need to provide sport fishing is recognized, we must also strive to ensure that native populations survive. For a discussion of the philosophy of fish introductions see Courtenay and Robins (1989) and Ferguson (1990).

In this review of fish management we will deal mainly with game or "sport" fish under the following topics: past and present management practices for both cold- and coolwater species; the history and role of fish culture; and the status of trout farming.

2.1 Management Practices

Coldwater Fisheries

Coldwater fishes are those which prefer summer water temperatures ranging from about 10°C to 18°C. These conditions are found primarily in streams and lakes of the eastern slopes and the northern forests, but pothole-type lakes suitable for trout also dot the prairie and parkland regions. In Alberta the coldwater species include seven species of trout, two whitefishes, and the Arctic grayling. Four of the trout species are native to the province: cutthroat trout in the south-west, rainbow trout in the upper Athabasca drainage, bull trout in headwater areas from the Oldman River system to the Peace River system, and lake trout in scattered locations in deep cold lakes throughout the province. Brook trout were introduced to the Bow River system from eastern Canada as early as 1910 and brown trout were first stocked in the province in 1924. Golden trout were added in 1961. Widespread stocking of rainbow trout has occurred since the 1930s.

During the early part of the first quarter of the century, the management of coldwater fishes was limited to prescribing daily bag limits and seasonal closures for trout angling. However, as settlement of the province progressed through this period, declines in the quality of angling were already noted and this led to the establishment of fish hatcheries in the National Parks and to the trout introductions referred to above. Stocking of various species, mainly cutthroat, rainbow, brook, and brown trout became common during the latter part of the period and into the 1930s.

Through the next decade the main management strategies consisted of: expanded stocking of eastern-slope streams with fingerling trout, declaring an 8 inch (20 cm) minimum size limit on trout which could be kept, permanent closure of many small trout-bearing tributary streams which were believed to be principal spawning areas, and permitting generous daily catch and possession limits of 15 and 30 trout respectively. The 1940s also saw the beginning of research and investigation into fish populations and conditions in lakes and streams by such noted scientists as D.S. Rawson and R.B. Miller. These investigations were important since they were to lead to significant changes in fishery management in subsequent years.

In the 1950s, for example, it was shown that the survival of hatchery reared trout, especially fingerling-sized trout, was poor when they

were released into streams and that routine stocking contributed little if anything to angling success. It was also demonstrated that the permanent closure of small and medium-sized tributary streams resulted in the loss of considerable stream fishing opportunity, while making little difference to trout populations in the larger rivers. As a result of these findings regular stream stocking with hatchery trout was discontinued; stocking of flowing waters was limited to beaver ponds where little or no spawning occurred and to the introduction of a species to new waters, e.g., cutthroat trout were put into several parts of the North Saskatchewan River system. A system of opening and closing tributary streams on alternate years was substituted for the permanent closure of tributaries. The minimum size limit of 8 inches (20 cm) was discontinued.

Hatchery trout production actually increased when these changes were adopted because stocking shifted from streams to lakes and reservoirs. Experiments in fish stocking showed that small lakes unoccupied up to this time by sport fish could produce good crops of trout when stocked. Repeated stocking was necessary because the majority of these lakes provided no natural spawning habitat for trout. Thus trout production overall was increased and trout fishing opportunities were provided over a much larger area of the province than previously existed.

The 1960s saw few changes from the new strategies adopted during the previous decade. A reduction in the daily bag limit from 15 to 10 trout was perhaps the most noteworthy change. However, significant management considerations did occur in the 1970s and 1980s. The "Buck for Wildlife" program, which established a fund for fish habitat protection and improvement through an additional charge of one dollar for an angling licence, provided a start in the protection of trout streams from degradation by man's activities. Visible work accomplished under this program such as the fencing of stream banks helped to raise the level of public awareness to the problems of habitat loss. The 1970s saw international recognition of the lower Bow River as a superb trout fishery. This led to regulations on the number and size of fish that could be kept in order to maintain the high quality of this fishery. Examples of these regulations are: no trout over 40 cm in length caught in the lower section of the Bow River may be kept; the use of bait is prohibited; and the daily limit is two trout.

In the early 1980s, Alberta's first "catch-and-release" barbless hook stream trout fishery was introduced on the North Ram River. It was

believed that the introduction of this concept in this province would be vital to the conservation of certain species in specific habitat conditions. In the latter part of the decade, the upper sections of the Little Smoky River were also designated as a catch-and-release area to preserve the quality of the Arctic grayling fishery in that stream. A general reduction in daily and possession bag limits from ten to five trout and/or Arctic grayling accompanied the aforementioned management changes.

In the latter 1980s trout stream management was altered in other significant ways. Minimum size limits were re-introduced but were varied according to growth rates in different river systems. This regulation follows the principle of allowing trout to spawn at least once before being killed. The "fallow" system of stream management was discontinued in favor of annual open seasons but retaining closed periods during spawning seasons and during the winter months. In keeping with the concept of encouraging catch and release fishing, the use of bait in flowing water was banned for part of the year in many east-slope streams. Investigations have shown that fishing with bait contributes to fish mortality because baited hooks are taken deeply into the throat and gill damage often results. This measure was therefore designed to assist in the conservation of our coldwater fish resources.

Coolwater Fisheries

The species generally considered to belong to this group in Alberta are pike, walleye, sauger, yellow perch, goldeye, mooneye, and lake sturgeon. These species generally prefer summer water temperatures between about 18°C and 26°C; they spawn in the spring. In addition, there are some borderline cool- to warmwater native species and some warmwater introduced species. Until recently, coolwater species have received only minor management considerations. This was due mainly to public concerns being directed toward trout species. Reductions in bag limits and closure of streams tributary to lakes during spawning periods have been used as conservation measures. Minimum size limits on walleye (38 cm) and lake sturgeon (1 meter) have been adopted.

To maintain the high quality of angling in selected lakes where northern pike and/or walleye were of large size, special regulations declaring these waters to be "trophy lakes" were adopted in 1970. Daily bag limits on these waters are generally much lower than on other lakes (e.g., the Siebert Lake limit is 2 pike daily) and a special Trophy Angling Licence is required to fish for them. Baitfishing, spearfishing, and

bowfishing are banned in trophy lakes to further the conservation of large fish. In 1991 there were seven trophy lakes listed in the angling regulations.

In the early 1980s, due to the decline in walleye numbers in the province, a special management program for walleye was introduced. A hatchery and rearing pond system was established to provide walleye fingerlings for the restoration of some stocks that have seriously declined or have been all but lost. Since the decline in walleye populations was believed to be, in part, the result of heavy angling pressure, reduced open season lengths and reduced bag limits have also been applied as conservation measures.

2.2 History of Fish Culture in Alberta

As previously noted, fish culture has played a prominent role in fish management. Prior to 1930 when the responsibility for the management of natural resources was transferred from federal to provincial jurisdiction, the Government of Canada carried out fish management activities in the province. The construction of early fish hatcheries took place in the National Parks. The first hatchery was established in Banff in 1913. This was followed by a facility at Jasper in the early 1920s and then a third facility in Waterton National Park in 1928. The main purpose of these fish hatcheries was to introduce and maintain game fish (primarily trout) in the many mountain lakes which lacked native species of trout. The species produced for this program were rainbow, cutthroat, and brook trout and to a lesser extent splake and brown trout. In addition to stocking lakes in the mountain parks, some of the fish from the Banff and Jasper hatcheries were stocked in provincial waters adjacent to the parks.

The first trout hatchery in the province outside the National Parks was established in 1936 by J.B. Cross of the Calgary Brewing and Malting Company. It was not until 1940, however, that this hatchery began to produce sufficient numbers of trout to allow for fairly widespread stocking of lakes and streams in the province. Shortly thereafter the provincial government entered into an agreement with the Calgary Brewing and Malting Company whereby operation of the hatchery became a joint venture between the two agencies. This arrangement continued until a modern provincial hatchery, the Sam Livingston Fish Hatchery, was erected on the William Pearce Estate in Calgary and began operation in 1973.

In conjunction with the Calgary hatchery a number of fish rearing stations were operated at various times and places and with varying degrees of success. These rearing stations were designed to raise trout from small fingerlings to the yearling stage or older before they were stocked into provincial waters. Most important among the rearing stations was the Raven Rearing Station near Caroline which operated in this capacity from 1937 to 1976. Other trout rearing was carried out in smaller facilities located at Pincher Creek, Big Hill Springs near Cochrane, Westmount in Calgary, and at Sundance Creek near Edson. These latter operations were in service for a limited time in the 1940s and early 1950s. They were phased out because of improvements in fish transporting equipment and consolidation of the rearing process at the more suitable Raven station site. The development of the Sam Livingston hatchery led to a shifting of virtually all trout rearing to that complex and as a result the function of the Raven station changed in the late 1970s from trout rearing to a trout brood stock and egg production facility.

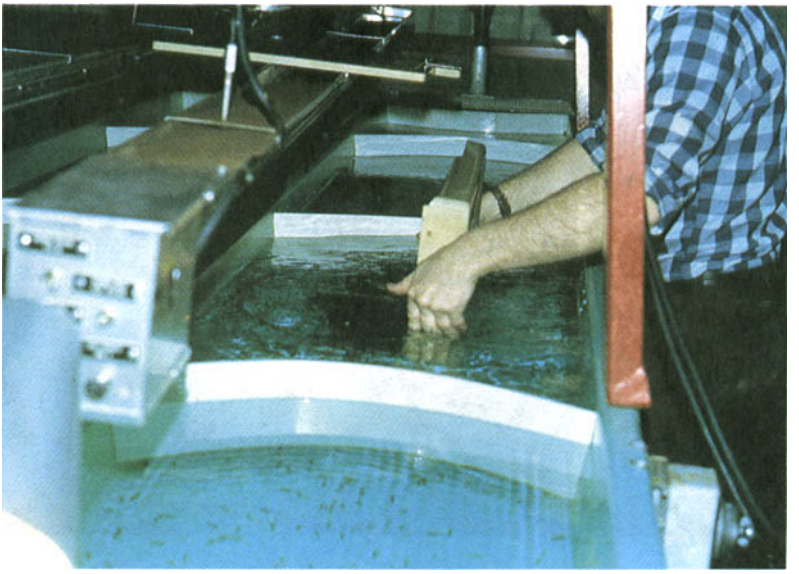
A small privately owned trout rearing station known as the Sundance station near Wabamun Lake was purchased by the government in 1983 to supplement the trout rearing capacity of the Sam Livingston station.

An integral part of fish culture is providing fish eggs for hatchery operations. Eggs are usually obtained from two sources, namely, wild adult trout in lakes and from captive adult trout kept at "brood stations." The first of such brood stations in Alberta operated at the well known Hunter Ranch west of Fort McLeod from 1941 to 1953. When trout eggs became available in quantity and at a reasonable cost from commercial brood stations in the United States, the province turned to these suppliers for approximately the next 20 years. In the 1970s, however, concern for securing a dependable disease-free egg supply and the development of regulations in Canada concerning the importation of trout and trout eggs, led to the conversion of the Raven Rearing Station to a rainbow trout brood station. Subsequently a new trout station was established near Coleman, Alberta, which was designed primarily for supplying brook trout and brown trout eggs. This facility, known as the Allison Creek Station, also has limited capacity for some hatching and early rearing. It began operation in 1982.

Some trout and Arctic grayling eggs are still obtained from wild fish populations. For example, cutthroat trout eggs are taken from adult trout in Job Lake and Arctic grayling eggs have at times been obtained from stocks in the Beaverlodge River.

A view of the Raven Trout Rearing Station (1963) prior to conversion to a trout brood station. Photo courtesy of W. Schenk.

Examining trout eggs in incubators at the Sam Livingston Fish Hatchery. Photo courtesy of W. Schenk.



Transferring trout fry to rearing troughs at Sam Livingston Fish Hatchery. Photo courtesy of W. Schenk.

Rearing trough room in the Sam Livingston Fish Hatchery. Photo courtesy of W. Schenk.

Trout fingerlings in the Sam Livingston Fish Hatchery. Photo courtesy of W. Schenk.

Releasing hatchery-raised trout from a transport truck into Upper Kananaskis Lake. Photo courtesy of W. Schenk.

Log wall constructed by the Edmonton Chapter of Trout Unlimited on Little Sundance Creek to control bank erosion. Habitat improvement projects such as this have been carried out on a number of east slope streams. Photo courtesy of M. Knopp.

The most recent development of fish culture facilities in the province has been the establishment of a trout and walleye hatchery at Cold Lake. By 1980 the requirements for hatchery trout had exceeded the capacity of the Sam Livingston hatchery and the initiation of the previously mentioned walleye restoration program led to construction of this facility. Operations at this site began in 1986.

One further element in the development of fish culture in the province was the existence of a lake whitefish hatchery on the south shore of Lesser Slave Lake (Canyon Creek) from 1928 to 1944. Its purpose was to incubate large numbers of whitefish eggs to within several weeks of hatching. In late March or early April these "eyed-eggs" were transferred to various lakes in the province to either start new populations of lake whitefish or supplement the existing natural supply. When it was determined through research of Dr. R.B. Miller that supplemental stocking of whitefish eggs had little or no effect on the numbers of adult whitefish in a given lake, the whitefish hatchery was closed and emphasis was placed on the management of wild stocks of this species.

Fish culturalists everywhere wage a constant battle against disease in hatcheries and rearing facilities. Young fish reared in large numbers

in relatively confined areas are subject to various stresses so diseases are not uncommon. Facilities in Alberta have a history of very low incidence of disease due in large part to the diligence of fish culture staff in maintaining sanitary conditions and taking appropriate action when unusual behavior is noticed. Notwithstanding these efforts, however, a major viral disease outbreak of infectious panceatic necrosis (IPN) occurred in the Cold Lake (in 1987-88) and Calgary (in 1989) facilities. As a result, these hatcheries were temporarily closed to permit total disinfection. Fish production is gradually being restored and is expected to be at capacity by 1993. The IPN virus occurs naturally in many Alberta waters and special care is required to keep it out of hatcheries.

2.3 Trout Farming

Trout farming refers to the rearing of trout in captivity usually by private individuals for recreational or commercial purposes. Interest in these ventures developed in Alberta when it became apparent that rainbow trout grew rapidly in dugouts, small ponds, and shallow lakes. People who had water bodies of this kind within the confines of their private land holdings requested the government to provide a licencing system which would enable them to raise trout for either pleasure or profit. Accordingly, in 1961, trout farming became established in Alberta and two types of licences were issued. Private fish farm licences permitted the raising of trout on private land for recreational use, while commercial fish farm licences provided for raising trout for sale. In both instances it is a requirement that the water bodies in which the trout are to be kept are completely contained on privately owned land or on patented leased land. The impoundment of creeks or rivers for the purpose of trout farming is not permitted. Trout farming operations are subject to inspection by government personnel in order that disease problems in fish can be controlled.

The majority of trout farmers are those who wish to produce trout for the table and for recreational fishing. Commercial licencees are mainly involved in providing fingerling or larger trout for sale to private licencees or to a lesser extent for the food market. Most of the commercial producers import their stocks from sources in the United States which have been certified to be free of certain specified diseases. Few have their own hatching facilities. In 1989 the province issued 83 commercial fish farm licences and 1741 private licences.

While the trout farming industry is not large in Alberta, it has provided many additional angling hours of recreation on private lands as well as an income for a number of commercial operations.

3 Fish Ecology

AS FISH NATURALISTS KNOW, most species tend to predominate in particular areas within a body of water. Different individuals may venture into all available areas within a lake or stream but, in general, each species has its own particular preferred habitat. One species may spend the summer in deep cold areas of lakes while another may prefer the shallow weedy areas. It is the dynamic interplay of many factors—environmental preferences and tolerances to such things as temperature and oxygen concentration, relationships with other species, availability of spawning area, and the location of their preferred food—that determines where a particular species will predominate. Variation in the relative abundance of various species between lakes and streams is also related to the same factors. A knowledge of a species' preferences and tolerances under a variety of conditions of a fishes life (e.g., feeding and spawning) is important in many basic research studies on fishes as well as important in such management studies as predicting the impact of environmental change on fishes. Many details of the individual factors and their interrelations await investigation.

In all environments, the interaction of individuals of different species is also highly important in determining where a species will live and its relative abundance. Individuals may be absent from an area due to their inability to compete with individuals of another species rather than to a lack of tolerance to the physical environment. Young brown trout, for example, often force native cutthroat trout and bull trout out of their preferred areas and into less favorable ones.

It would appear that most species of fish in Alberta have wider tolerance for a variety of ecological conditions and occur in more diverse habitats than do species in areas where the number of species is

greater. Many species in Alberta are at home both in lakes and rivers and are not restricted to any particular habitat. This is undoubtedly related to the fact that all of Alberta's native fish have quite wide distributions. A relatively large number of the species extend across North America and have obviously had good powers of dispersal. In contrast, species south of the limit of Pleistocene glaciation often tend to be more restricted to particular habitats than our species. Perhaps evolution favoring habitat specialization permits more species to coexist but also makes it more difficult for them to disperse to other areas. This does not mean, of course, that species in Alberta are immune to environmental change.

3.1 Temperature and Dissolved Oxygen

In the summertime, fish in most deep Alberta lakes experience a wide temperature range in their environment. The surface water may be 15-20°C while the bottom water may be close to 6-8°C. Although the uninsulated body of a fish is at about the same temperature as its immediate environment, each species tends to prefer a particular range of temperature. Providing that other conditions are suitable, they will occupy the depth where that temperature range occurs. For example, northern pike and yellow perch prefer relatively high temperatures and tend to occupy shallow waters; lake whitefish and lake trout prefer relatively low temperatures and tend to be found in deep waters in the summer. Fish can usually swim most efficiently and are healthiest at their preferred temperature. Of course, the preferred habitat is not solely determined by temperature but can be modified by preference for other factors, such as light, dissolved oxygen, and shelter.

Temperature is probably "measured" by the fish with special receptors along the lateral line. The particular temperature that an individual fish prefers depends, in part, on its species, on the temperature of water it has been exposed to in the preceding days, and on the fish's age. Individuals accustomed to cold winter temperatures generally have a preference for warmer water. If a lake warms up unusually fast in the spring, fish may move into water which is warmer than they can withstand and as a result they may perish. The lethal temperature, or temperature at which fish will be killed, varies between fish species and on the past temperature experience of the fish. A fish accustomed to 4°C, for example, may die if it moves into a temperature of 20°C in shallow bay areas or in thermally polluted water; but the same fish may be

able to tolerate that temperature quite well in the summer, although possibly preferring a lower temperature. Alternately, a fish accustomed to 20°C may die if it is relatively quickly exposed to 4°C, even though it may be able to live at that temperature if slowly adapted to it (for an example, see Ash et al., 1974). It would be expected that natural selection results in individuals of a species having a temperature preference that favors their ultimate ability to successfully reproduce. Because temperature has such a profound influence on features of the biology of a fish such as growth rate and spawning time, we often categorize species in terms of their temperature preference and spawning temperature as being coldwater, coolwater, or warmwater species (see also Section 2.1, Management Practices).

Fish also vary in their requirements for dissolved oxygen. Whitefish and trout require relatively high oxygen concentrations while fathead minnows and brook sticklebacks can tolerate relatively low oxygen conditions. In some Alberta lakes of moderate to shallow depth that are protected from strong wind action, the oxygen concentration near the bottom of the lake becomes very low during late winter and late summer. During these times, fish are forced to move up toward the surface. In the summer months this often means that coldwater species must move into water warmer than they prefer, which may prove to be lethal. Thus, coldwater species such as lake whitefish and lake trout cannot live in lakes that lack the cool well-oxygenated zone so typical of northern Alberta lakes.

Dissolved oxygen diminishes in the winter when the lake is sealed off from the atmosphere. This oxygen depletion is due to the respiration of living organisms including some bacteria which decompose dead organisms. Respiration consumes oxygen and releases carbon dioxide and sometimes, if the oxygen concentration drops to zero, methane and hydrogen sulphide may be released by bacteria able to live in the absence of oxygen. Dissolved oxygen depletion is most rapid at the bottom of the lake. The loss of dissolved oxygen is hastened by snow cover and cloudy ice which eliminates sunlight penetration and thereby prevents algae from adding oxygen to the water during photosynthesis. Massive fish die-offs may occur in some lakes during late winter due to lack of oxygen. Such die-offs may also occur during circulation of the water in the lake following ice break-up if oxygen concentration is very low or if enough toxic materials accumulate during the winter; this is known as "winterkill." Similar die-offs may also occur in the summer and in the fall but this is rare in Alberta. Usually, not all fish

are killed. Much to the fishermen's and fishery biologists' distress, game species, which require more oxygen than do most nongame species, are usually killed off first or may be the only species to die. Summer oxygen depletion is relatively rapid in warm highly productive lakes of moderate to shallow depth in central and eastern Alberta, especially after an algal bloom dies off and decomposes. Oxygen depletion is slow or nonexistent in the cold unproductive lakes of the Rocky Mountains. Occasionally one encounters an oxygen condition which is the opposite to oxygen depletion. This condition is known as "supersaturation" and occurs when more dissolved oxygen is present than the water would ordinarily contain at a given temperature. Supersaturation is often recorded in effluent streams from thermal power plants where the water has been warmed, and in lakes which have dense growths of algae in midsummer. Supersaturation can be stressful to fish in cases of prolonged exposure.

The series of seasonal events in a deep lake are shown in Fig. 3.1a. Lakes are frozen over for about 4-6 months in central Alberta and 4-7 months in the Rocky Mountains. During this time the water temperature ranges from 0°C under the ice to as much as 4°C lower down, because fresh water is its densest (i.e., heaviest) at 4°C. Ice thickness is seldom greater than 1 meter. After ice break-up the surface water is quickly warmed until the entire lake is of uniform density. Deeper water is warmed only by currents produced by wave action forcing down surface water through eddy currents. During this time of circulation there is little or no stratification in temperature and dissolved oxygen. During periods of little or no wind action, the surface waters may warm up and become sufficiently lighter than the deeper cooler water that even strong winds cannot thoroughly mix the surface with the bottom waters. The upper layer of warm water, which circulates under wind action and tends to be well-oxygenated, is termed the "epilimnion" (meaning "upper lake"). Algae and rooted aquatic plants occur only as deep as the depth of sunlight penetration which is, in turn, governed by the turbidity of water. In general, zooplankton is most abundant in this region.

Immediately below the warm surface layer there is a zone in which the water temperature drops rapidly; this zone is termed the "thermocline" or "metalimnion." This layer, one to a few meters thick, usually is pushed deeper into the lake as the summer progresses. This in turn causes some fish species to move into deeper water, provided that other conditions are suitable. The depth of a thermocline in a lake

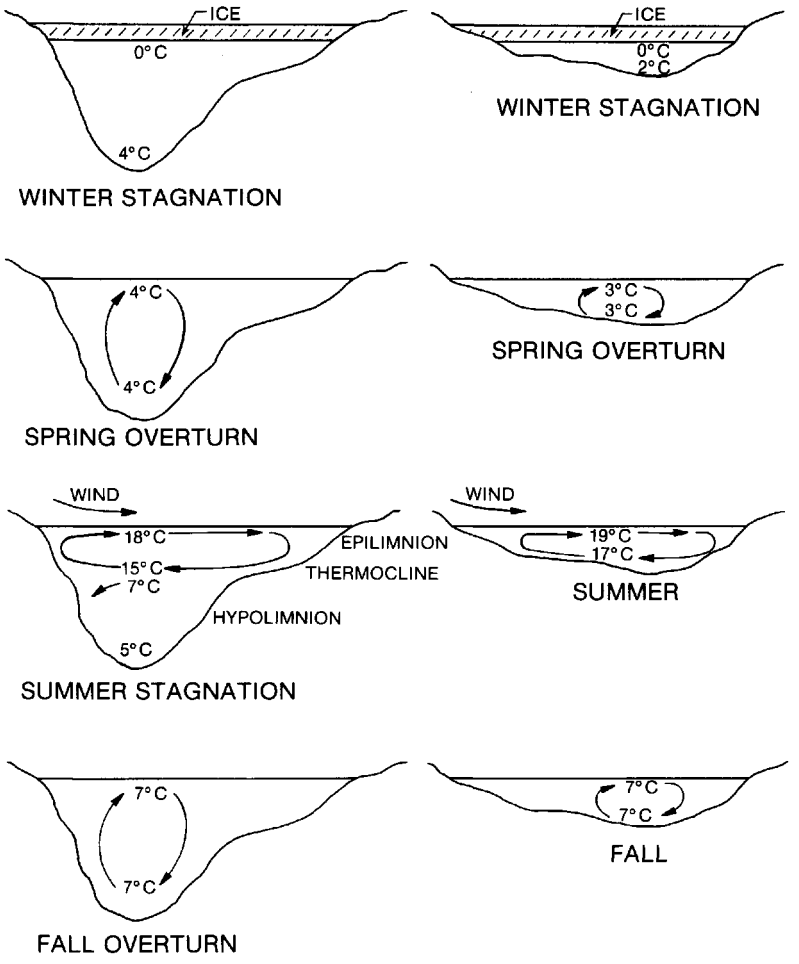


Fig.3.1a Example of seasonal temperature changes in a deep lake (left side) and shallow lake (right side). There is much variation in what may actually happen depending on such things as air temperature and the amount of wind. Summer stagnation may occur in a shallow lake if there is little or no wind action.

depends on the amount of wind action and may start anywhere from about 2 to 20 m. Most shallow lakes and many moderately deep Alberta lakes exposed to strong wind action never develop a thermocline. Depending upon annual climatic differences, a lake may develop a stable thermocline one year but not during another.

In thermally stratified lakes the area of cool water below the thermocline is termed the "hypolimnion" (meaning "under lake"). This

area, due to the lack of circulation from the surface, cannot gain oxygen during the summer as can the epilimnion. In lakes of moderate depth the hypolimnion may be much smaller in volume than the epilimnion and may become very oxygen deficient; in deep lakes the hypolimnion may have a large volume and may not become seriously deficient in oxygen. When temperatures drop in the late summer and early fall the epilimnion cools to a temperature near that of the hypolimnion. Then, when the density difference is small, winds cause the circulation of the lake once more and the thermocline is lost and the lake is uniform in temperature from top to bottom. Despite the isothermal state of the lake, many species of fish are still found at different depths because of other factors. During fall overturn, bottom water comes into contact with the surface and if the winds are sufficiently strong, the lake will become saturated in oxygen before freeze-over in November or December. The entire lake is cut off from contact with the atmosphere after ice cover forms.

Horizontal zonation of fish around a lake's margin, in addition to vertical zonation, is also commonly observed. Shoreline areas may consist of barren rock, sand, gravel, marl, and rooted aquatic plants. Each such area may differ in the relative abundance of species due to different preferences.

3.2 Types of Lakes

The terms for various bodies of standing water and the ecological regions of a lake are shown in Fig. 3.2a.

Oligotrophic lakes, such as Cold Lake (main basin), Crowsnest Lake, and Waterton Lake, typically have a small littoral region, are very deep, and are low in dissolved nutrients and organic matter. Eutrophic lakes, such as Lac Ste. Anne and Pigeon Lake, typically have an extensive littoral region, are relatively shallow, and are rich in dissolved nutrients and organic matter. Sedimentation tends to change an oligotrophic lake into a eutrophic lake with a resulting increase in productivity, but this process may take thousands of years. A lake type which is intermediate in productivity between these two types is recognized as a mesotrophic lake, for example Gull and Sylvan lakes (Mitchell and Prepas 1990).

Ponds may result from further reduction in depth of a lake which enables submerged vegetation to cover the bottom if other conditions permit. Additional sedimentation or initial shallow conditions with the groundwater table at the surface results in a wetland with emergent

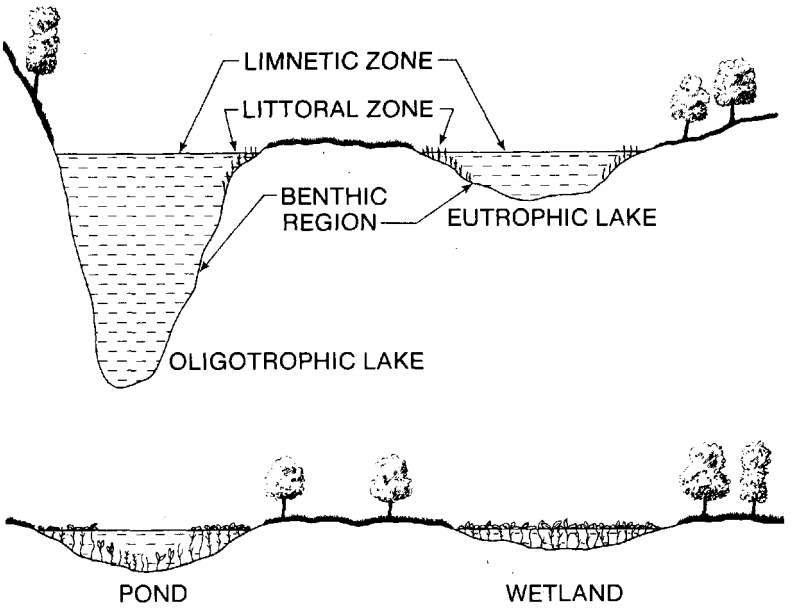


Fig.3.2a The ecological regions of two extreme types of lakes and their succession into the pond and wetland stage. In a normal ageing process during which sedimentation is occurring, an oligotrophic lake becomes a more productive eutrophic lake which in turn may become a pond. In further change a wetland may result. The littoral zone or region is the shallow water area characterized by rooted emergent or floating vegetation (colloquially termed weeds); the limnetic zone or region consists of open water; the benthic region is the entire substrate (bottom). Organisms which are at the mercy of currents in the limnetic and littoral region are termed planktonic (animals = zooplankton; plants = phytoplankton). The benthos consists of organisms that move on the substrate, are attached to it, or burrow into it.
NOTE: The vertical scale representing depth has been greatly exaggerated relative to the horizontal scale in all four drawings.

vegetation, cattails and sedges, and no significant open water area during maximum vegetative cover. The typical prairie slough, whether having permanent or seasonal water, is usually a small pond or wetland region. The term "marsh" is used by some people for this condition whereas to others it implies just a spongy wetland. Some may use the term "swamp" if there are trees but "marsh" if there are not, or they may differentiate between the two by whether there is permanent water (swamp) or not (marsh). Wetlands without significant peat may be termed swamps or marshes and are found primarily in the aspen parkland and grassland regions. On the other hand, if there is a significant amount of peat (in areas collectively termed "peatlands"), as often

found in the boreal forest, there may be a productive alkali sedge fen maintained primarily by groundwater or a relatively unproductive acidic sphagnum-moss bog maintained primarily by precipitation. The fen is the commonest peatland in Alberta; peatlands, whether fens or bogs, are frequently termed muskeg—the ground is usually spongy and the area dominated by moss, black spruce, and shrubs. While there may be a temporal sequence in proceeding from an oligotrophic lake to a fen due to sedimentation, any stage may result following glaciation depending on topography and climatic conditions. Wetlands are normally devoid of fish, but they are nevertheless an important aquatic environment. There are differences in the use of some of the above terms between different parts of Canada, let alone the world, and between and among biologists and lay people of a given region.

Information of the size and depth of some of our lakes is given in Appendix II. Chipeniuk (1975) presents information on the numerous lakes in the Lac La Biche district and Mitchell and Prepas (1990) present detailed information on one hundred Alberta lakes.

3.3 Rivers and Streams

Stream fish also live in a variable environment and their distribution is a reflection of differences in preference. Streams usually have sufficient oxygen for fish and are similar in temperature from top to bottom. However, species may be segregated on the basis of differences in bottom materials, strength of current, and depth of water. In streams, as in lakes, the presence of aquatic vegetation is necessary for some species. For example, brook sticklebacks require vegetation in order to build their nest. Much of the North Saskatchewan River is unsuitable for sticklebacks to reproduce because of the absence of suitable aquatic plants. Plants are rare or absent due to the large fluctuation in water level in this silty stream, the low light penetration, and the scouring action of ice and flood waters. Marked differences in species can be observed in proceeding from the lower elevations of rivers in eastern Alberta upstream to the headwaters in the Rocky Mountains. Although certain temperature conditions and stream gradients are associated with these differences, the explanation for the differences is poorly understood. Species thriving in the upper portions of Alberta rivers are often found in the lower portions of rivers elsewhere (e.g., mountain whitefish).

Information on the drainage basin size and discharge of our large rivers is presented in Appendix III.

Coral Lake. Cline River drainage. An example of the numerous small mountain lakes found in the Rockies. Some of these lakes are stocked with trout to provide a wilderness angling experience. Photo courtesy of L.A. Shea.

North Raven River near Caroline. One of Alberta's most productive spring creeks noted for its brown trout population. M.J. Paetz.

A large beaver pond in the Alford Creek-Clearwater River drainage. Flowing water is changed to pond-type aquatic habitat. M.J. Paetz.

A section of trout stream showing habitat deterioration due to livestock grazing along its banks and margins. M.J. Paetz.

Elk Creek-North Saskatchewan River drainage. This foothill's stream has moderate current and good cover and generally provides adequate habitat for trout. M.J. Paetz.

Storm Creek, tributary to the Highwood River. An example of the numerous headwater streams on the eastern slopes of the Rockies. M.J. Paetz.

Highwood River west of Highwood Junction. This section is typical of our medium-sized mountain rivers. M.J. Paetz.

Christina River in northeastern Alberta. This stream is fed by water reserves in muskeg areas. It is well known for Arctic grayling fishing. M.J. Paetz.

Milk River near the town of Milk River. A river of the short-grass prairie area. The stonecat, a member of the catfish family, is found here. M.J. Paetz.

Hornaday Creek, Wood Buffalo National Park. This tributary of the Slave River is a small northern woodland stream. M.J. Paetz.

Mountain Rapids on the Slave River, Alberta. One of a series of scenic rapids on this large northern river. Arctic lamprey occur in this vicinity. M.J. Paetz.

Salt River southwest of Fort Smith, Wood Buffalo National Park. Note salt deposits along the banks. Northern pike, walleye, longnose sucker, and ninespine sticklebacks are common here although the water has a high concentration of salts (Nelson and Paetz 1972). M.J. Paetz.

3.4 Productivity of Lakes and Streams

The abundance and annual rate of increase in numbers of fish are governed by the productivity of the water, that is, by its ability to produce organisms which in turn may be used as food. Waters rich in inorganic nutrients and having a long gentle sloping shoreline are more productive than waters with low concentrations of nutrients and steep rocky shorelines. Water transparency is important in determining to what depth phytoplankton (algae) and rooted plants can live and is consequently related to a lake's production. Waters which are turbid due to high silt content tend to be unproductive even if they are nutrient rich. Silt-free water allows increased production in phytoplankton, however, abundant plant and algal growth decreases water transparency and further production is checked. Very clear water such as in Waterton Lake is a sign of low productivity. Some lakes, such as Astotin in Elk Island National Park, are highly productive. Algal blooms in the summer can leave the water a bright blue-green or green and allow little light penetration. Wind may concentrate these water-blooms into a paint-like mess which can be toxic to fish, birds, and mammals. When the algal bloom dies, its decomposition consumes massive amounts of oxygen. The resulting oxygen depletion is often so severe that most fish die. (A guide for the investigation of fish kills is provided by Meyer and Barclay (1990)). Only fathead minnows and brook sticklebacks currently live in Astotin Lake despite the introduction of other species. Salt concentrations are so high in some lakes in southeastern Alberta such as Oliva, even higher than in the ocean, that none of our native species can live in them.

3.5 General Biology of Alberta Fish

In contrast to many tropical species which tend to have specialized feeding habits, Alberta fishes are relatively generalized, that is, they tend to eat what is available. They may be generalized and able to eat substrate food items (bottom or benthic), midwater items, and surface items (both aquatic and terrestrial in origin), or be somewhat more specialized. For example, some species are primarily substrate feeders (e.g., lake whitefish and suckers), others are openwater plankton feeders (planktivores, e.g., such as cisco), still others may be surface feeders (e.g., introduced mosquitofish), and finally some species are fish feeders (piscivores, e.g., such as northern pike and walleye) (see

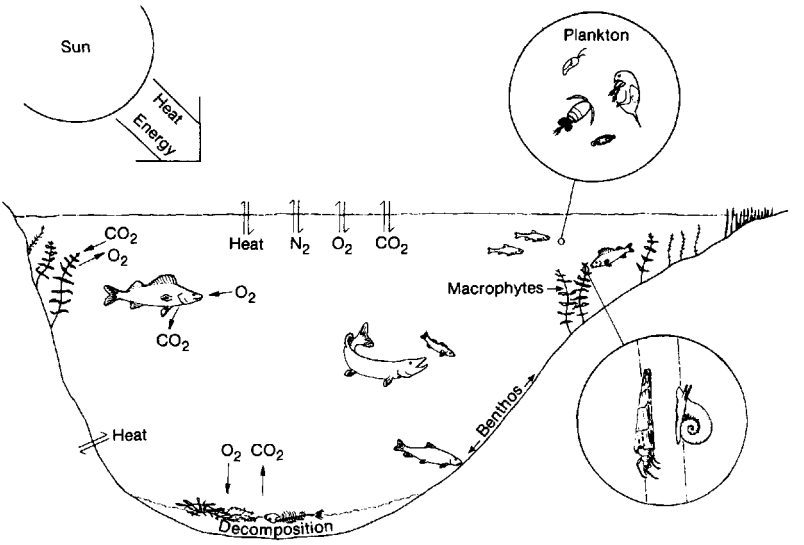


Fig.3.5a Figure showing in simplified form some of the dynamic interactions occurring within a lake. Oxygen is gained through surface exchange with the atmosphere and as a by-product of photosynthesis by plants such as planktonic algae and the macrophytes (rooted aquatic plants). Oxygen is consumed by respiration of living animals and some bacteria decomposing dead plants and animals. Heat, carbon dioxide, nitrogen, and other substances are also exchanged and have their own cycles. Fish in Alberta typically feed on plankton (plants and animals essentially at the mercy of water currents), benthic animals (ones on the substrate), or on other fish. No native fish feeds significantly on macrophytes.

Fig. 3.5a). Their mouth shape and position and their gillrakers often show obvious adaptations for the type of food upon which they feed. Most trout-like fish are quite adaptable and are not highly specialized in their feeding requirements. Differences in feeding habits may occur during the life of an individual fish; for example, larval suckers feed near the surface on plankton whereas older individuals feed on the substrate on benthic organisms.

The fish biologist must often identify and quantify the stomach contents of a fish to reveal what it has been eating. An excellent guide to the identification of the aquatic invertebrates of Alberta, many of which may be expected to be eaten by some species of fish, is provided by Clifford (1991).

Every body of water has a certain limited carrying capacity. There is a maximum amount of fish that can be supported over a period of time. This capacity, which may vary from year to year, depends primarily

upon the productivity of the water body and climatic factors and is only realized if species of all different feeding habits are present. A lake with only substrate (bottom) feeding whitefish or suckers will not reach its maximum carrying capacity. On the other hand, the carrying capacity for an individual species is usually highest when competitive species are absent. A particular lake capable of supporting a given amount by weight of trout may have many stunted adults or a few large ones. Limited spawning area and high predation rates may be conducive for the latter. Over-stocking, of course, will only result in lean fish when the abundance of food is limiting.

Spawning time in fish is governed by daylength and water temperature. Every month has one or more Alberta species spawning, each species responding to a slightly different daylength and water temperature for spawning. Fish vary in their methods of reproduction. Sticklebacks build nests of aquatic vegetation, have an elaborate courtship behavior, and care for the relatively few eggs and for the young after hatching. Trout dig cavities, called redds, in gravel and cover the deposited eggs but do not care for them afterwards. Suckers, at the other extreme, release many thousands of eggs after a very short and simple courtship, without providing any care for them. Some species go on rather lengthy migrations for spawning, as appears to be the case for some of our walleye and goldeye, or they may spawn near areas that they frequent for food.

Unlike warm-blooded animals (endotherms, that is, birds and mammals), fish grow throughout their life; however, growth rate usually decreases with age and may be very slow in an old fish (see Fig. 3.5b). Deviations from the smooth curve shown in Fig. 3.5b may occur if there is a change in diet as the fish gets larger; if, for example, upon reaching a certain critical size it starts feeding on other fishes an increase in growth rate may result. Their growth is usually in a series of steps, faster in summer and slower in winter. The reduced growth rate in winter usually results in changes in patterns laid down in growing bony parts, including scales, that can then be used to determine the age of the fish (the "winter" mark is termed an "annulus"). Methods for aging Alberta fishes may be found in Mackay et al. (1990). Some of the most useful structures for calculating age are those in which annular rings (annuli) are laid down similar to what happens in a tree; these structures include the otoliths, fin rays, and vertebral centra. Scales are frequently used for age determination, but the nature of the annular mark differs from that of all other bony parts. In scales a series of rings termed

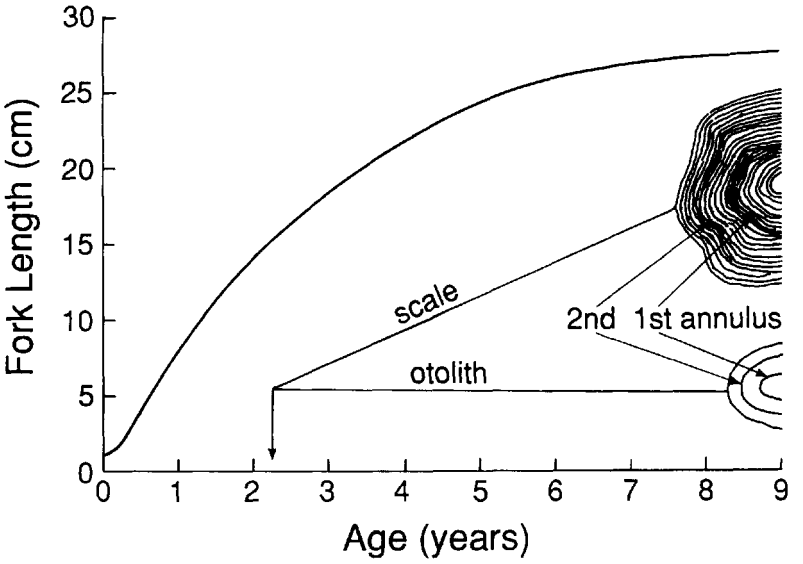


Fig.3.5b Hypothetical growth curve of a summer-hatched fish and two structures used in determining age (shown for a 2+ fish, one having passed through two winters and showing growth in its third summer). A fish typically has continuous or indeterminate growth throughout its life, although seasonal differences do occur.

"circuli" are laid down each year, the pattern of which differs when growth rate is increasing, as in late spring, from that during the rest of the growing season (in scales, the annuli are made up of circuli forming a different pattern than typical summer circuli). However, there are many problems in correctly identifying the period of annular increase in growth rate, and it may be impossible to use scales to calculate the age of slow growing fish or of old fish. The length of the growing season may vary a great deal between lakes and streams and within localities between years due to a variety of reasons. Also the rate of growth at any particular time for a given species may vary between localities. All of this results in different overall growth rates in a given species between localities and between individuals within a locality due to environmental and genetic differences (in general, one expects growth to be slow in cold streams and lakes, such as those in the Rocky Mountains). Similarly, features such as color, head size, and number of scales may differ between individuals within a given water body and between water bodies. These differences may also be the result of an interaction of genetic and non-genetic factors.

4 Post-Glacial Origin of Our Fish Fauna

FISHES HAVE BEEN IN Alberta for many millions of years and have left an extensive fossil record, but they have not continuously occupied the province. For a variety of reasons, there have been many interruptions to their existence here. Most of Alberta, and indeed most of Canada, was probably covered by ice during the last ice age between about 20,000 and 13,000 years ago. Prior to our last ice age, it is possible that fishes occupied Alberta up to as recently as 20,000 years ago. Available evidence (e.g., Rains et al. 1990) suggests that the present fauna may in general have gained access to the province only 13,000 or so years ago, after the last ice sheet melted. However, Schweger and Hickman (1989) document a period of aridity following the last glacial retreat, and it is possible that most of our lakes were too shallow to have their existing fish communities in place continuously to the present until about 9,000-5,000 years ago. Information relative to Alberta on the ice age is presented in Fulton (1984), Rutter (1984), Gadd (1986), Sadd (1986), Dyke and Prest (1987), Rains (1990), Rains et al. (1990), and Burns (1991) and information on the postglacial climate is in Schweger (1987, 1989), Schweger and Hickman (1989), and Anderson et al. (1989). As a result of these works, our views on some details of the reinvasion of Alberta fishes have changed from an earlier attempt to reconstruct the events of fish movement (Nelson 1977). However, there is still room for doubt on the extent and timing of ice advances and retreats in Alberta and consequently on the pattern of reinvasion of the fishes. Ongoing research may still substantially alter our understanding and interpretations of the events associated with the reinvasion.

Apart from events following the ice age as discussed in this section, the dispersal of fishes has been a continuing process. As noted by Paetz

and Nelson (1970), the construction of canals between drainages has provided artificial avenues for dispersal. For example, the St. Mary canal in Montana between the St. Mary and Milk rivers and the St. Mary-Milk River Irrigation development permitted fish exchanges between Oldman and Milk river drainages. In addition, introductions have played an important role in adding species that were not native to the province and in extending the ranges of native species. Of course, there has also been a decrease in the range of a number of species due to environmental changes. In all, the distribution of fishes today is no doubt somewhat different than it was 100 years ago.

4.1 Glaciation in Alberta

There has been a complex of several major glaciations, each with two major ice sheets, within North America over the last 1.7 million years (the Pleistocene epoch). The extent of all but the last and most extensive glaciation in Alberta is particularly uncertain. During the last (Late Wisconsinan) glaciation, the Cordilleran ice sheet was centered in British Columbia and extended into the Rocky Mountains while the Laurentide ice sheet covered much of the rest of Canada (that portion of the Laurentide sheet that may have extended into Alberta was centered in the District of Keewatin, to the northeast). During part of the last major glacial event Alberta was almost covered by ice, there being only a few small ice-free areas. However, there remains much doubt as to when and for how long this phase of maximum ice extent existed. In the Early Wisconsinan times, commencing about 85,000 years ago or earlier, much of Alberta may have been covered with ice. At the very least, the top of the Rocky Mountains escaped glaciation (such mountain tops protruding from a glacier are termed nunataks); in addition, there is no evidence that the uppermost Cypress Hills and uppermost Porcupine Hills were ever glaciated. There was a major retreat of whatever ice there was about 55,000 years ago. Then, during the ensuing Middle Wisconsinan non-glacial phase, if indeed the fauna and flora had been displaced prior to this, there probably was a movement of fishes and other animals along with plants into the province. The ice began to advance again and by about 18,000 years ago, during the Late Wisconsinan "maximum," the Laurentide ice may have coalesced with the Cordilleran ice sheet, this time to cover most of Alberta (Dyke and Prest 1987; Rains et al.1990). The fossil Arctic grayling from Alberta (Crossman and McAllister 1986; Burns 1991) is evidence of fish being

here at a time before the last major ice advance. An alternate view is that the Late Wisconsinan Laurentide ice advanced only as far southwest as Edson, Calgary, and Lethbridge and that the "maximum" ice coverage occurred in the earlier advance (the open region between the Laurentide and Cordilleran ice fronts is the so-called ice-free corridor, which is sometimes proposed as a route followed by early peoples in reaching southern parts of North America). However, the extent and timing of the "ice-free corridor" in Alberta between the ice masses and its implications to fish zoogeography is uncertain. It should be kept in mind that the results for the fishes are the same whether the ice sheets merged after the existence of a corridor and before general retreat or whether there were no suitable bodies of water for fish in the corridor areas between valley glaciers.

4.2 Refugia and Dispersal Routes

Areas where plants and animals, terrestrial and aquatic, occurred during the ice age are termed "glacial refugia" (hereafter referred to as "refugia"—we speak of refugia from our current perspective of living during an interglacial period; if instead we accepted the ice ages as the normal state we could refer to the interglacials as having expansion zones). During the Early Wisconsinan the potential refugia for Alberta species would have been ice-free areas in the Missouri-Mississippi drainage, the Columbia drainage, and the Yukon drainage. Species that are native to present-day Alberta survived in one or more of these areas (Fig. 4.2a). Recent papers discussing the movement of fishes that are relevant to Alberta are Crossman and McAllister (1986), Stewart and Lindsey (1983), McPhail and Lindsey (1986), and Lindsey and McPhail (1986).

Species of fish reinvading the province, or invading it for the first time after retreat of the glaciers, were limited in their dispersal to freshwater corridors, either lakes or rivers. There are thus definite limits set to any attempt in reconstructing the pathways of fish dispersal, stricter limits than exist in attempting to explain, for example, routes of reinvasion for most birds and mammals. However, it must be acknowledged that while one can differentiate between rigorous and unconstrained thinking in reconstructing pathways of reinvasion there is still an unavoidable element of story-telling to it. We can seek to identify the areas where the fish species occurred during the ice age and the routes they followed after retreat of the ice by knowing something

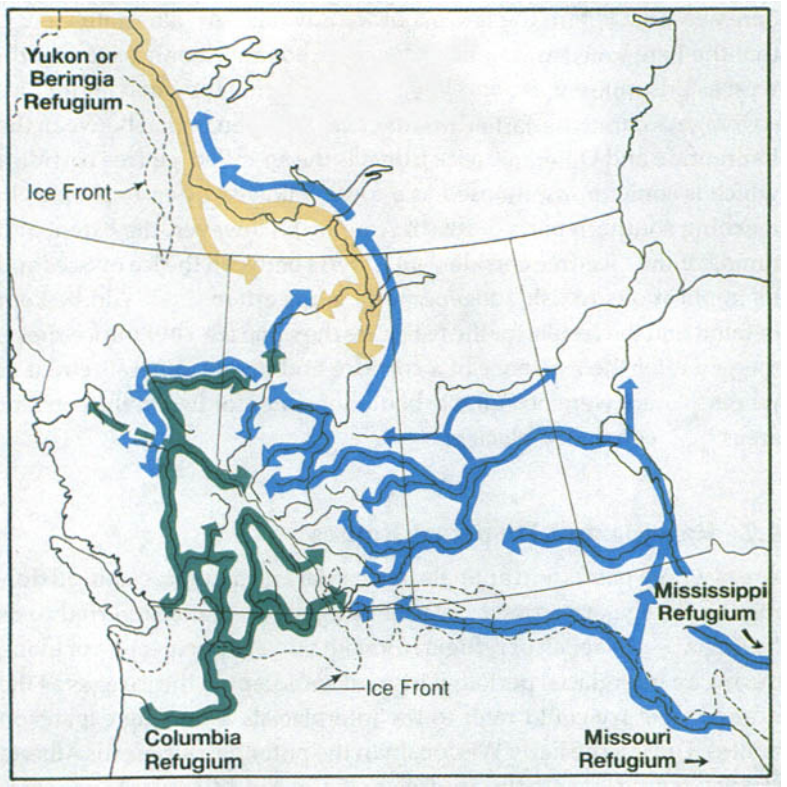


Fig.4.2a Postulated dispersal routes (generalized) of fishes into Alberta following the last ice age (blue from Missouri-Mississippi River refugium, green from Columbia River refugium, and orange from Yukon River refugium). Position of the ice front at maximum Late Wisconsinan glaciation is shown by dashed lines. The refugia are in ice free areas, beyond the indicated ice front (the ice front for the Mississippi refugium is not shown).

of the drainage patterns during the retreat of the ice and by studying the general distributional patterns of the fish. For example, species in Alberta confined to the Peace River but widespread in the Fraser and Columbia river drainages, such as the redside shiner, squawfish, and largescale sucker, almost certainly had a Columbia River refugium. Additional information to help identify the refugia and routes of invasion can be obtained from studying geographic variation in features of the fish and studying the fossils in known refugia of an age corresponding to when Alberta was covered by ice.

Western Alberta is a headwater region. As the climate warmed, the edge of the Laurentide ice sheet retreated downslope to the northeast. As a result, waters were often impounded by the ice fronts creating lakes that connected various drainages across low elevations; these areas of low elevation are now dry and create land barriers (St. Onge 1972). Thus, fish could move between the Athabasca and North Saskatchewan rivers about 12,000 to 13,000 years ago by way of various phases of Glacial Lake Edmonton. The North Saskatchewan and Athabasca river drainages are closely connected in some low lying areas even today, and fishes such as brook sticklebacks may still be subject to drainage transfer during exceptionally high run-off. The large glacial lakes and many melt-water channels carrying large volumes of water from the melting ice sheets are inferred to have made drainage transfer relatively easy. The low divides that fish and many other aquatic organisms used are sometimes proposed for future water management schemes as sites of drainage transfer—but that is another story.

Present evidence suggests that after the ice retreated the climate was relatively warm and dry. Lakes were much shallower than at present, for example Wabamun Lake may have been too shallow 9,000 to 5,000 or so years ago to support fishes. Subsequently, with a return to a cooler climate and increased precipitation, lake and river levels rose. Thus, there may have been an initial invasion following ice retreat, then local extirpation due to dropping water levels, and a subsequent and more localized invasion in the last few thousand years. If so, the outlets of many lakes, such as Wabamun, must have carried more water in the past in order to allow the upstream movement of fishes, especially that of lake whitefish.

From a study of the native species of Alberta fishes we deduce that the majority, some 38, came from the complex Missouri-Mississippian refugium. One-half of these native species belong to a group known as "ostariophysans," namely 12 minnows, six suckers, and one catfish. Some of these species such as the stonecat, western silvery minnow, and mountain sucker may have moved to Alberta directly from the Missouri via its tributary the Milk River. Various post-glacial connections between the Milk and Oldman drainages (e.g., St. Mary River) would permit further dispersal of these species to the Saskatchewan River drainage, some making it (e.g., mountain sucker) and some not (stonecat). Some species of Columbia River refugium origin, such as the mountain whitefish, probably moved in the opposite direction (i.e., eastward), although not necessarily at the same time as the Missouri

fish were moving northward (such two-way transfers were possible in other areas as well, e.g., white sucker moved from Peace to the Fraser drainage with the largescale sucker moving in the opposite direction). Most species, however, from the Missouri-Mississippian refugium such as the mooneye, quillback, and redhorse suckers, probably came from the Mississippi River via Glacial Lake Agassiz which extended across parts of Ontario, Manitoba, and Saskatchewan about 8,400 to 12,000 years ago (Dyke and Prest 1987). Alternately, some species may have moved into the province via Glacial Lake Agassiz from the Missouri River rather than the Mississippi itself. Seeb et al. (1987) present biochemical evidence that the Missouri and Mississippi drainages acted as distinct refugia for northern pike and that the northern pike in Alberta probably moved here via Glacial Lake Agassiz from the Missouri River. It is possible that other species that occupied the Missouri drainage during Wisconsinan time followed a similar route, and dispersal via the Milk River would also have been possible. Of course, some species may have moved into the province from both the Missouri and Mississippi rivers. Once in the North Saskatchewan system of Alberta, as noted above, the Missouri-Mississippian fishes could disperse into the Arctic drainage by way of Glacial Lake Edmonton. Once in the Athabasca River they could either disperse to the Peace River by moving downstream to the junction with the Peace thence upstream, or possibly by connections during heavy glacial melt between the two river systems such as from Lesser Slave Lake drainage (Athabasca system) and to Smoky River drainage (Peace system), or further upstream, between the Athabasca and Peace systems near Fox Creek. The deepwater sculpin in Waterton Lake may also have come from the Missouri refugium, but it is usually thought of as a glacial relict, in this case one dispersed by being pushed along in front of an advancing ice sheet from the Arctic and left behind as the ice retreated. We think it more probable that this species came from one of the three refugia along with other species.

The Columbia River refugium was second in importance to Alberta and about nine of our native species came from it. Mountain whitefish, largescale sucker, redside shiner, and northern squawfish in the Peace River probably arrived there by way of the Fraser River drainage (pygmy whitefish may also have used the same Columbia-Fraser-Peace route as did certainly the peamouth, a minnow which is in the Peace River of British Columbia but not yet recorded in Alberta). Such species may have gained access to the Fraser River from the Columbia River at a transfer route between the Shuswap basin and Okanagan basin

in the vicinity of Enderby and Armstrong, British Columbia (Glacial Lake Shuswap and Glacial Lake Penticton were once continuous). In addition, they may have used other routes such as one connecting the Similkameen drainage (part of the Okanagan system) with the Thompson drainage (part of the Fraser system) between Princeton and Merritt. Once in the Fraser River, the fish could move into the Peace system by way of a glacial lake north of Prince George. Mountain whitefish, pygmy whitefish, and rainbow trout and perhaps some other species in the headwaters of Athabasca River drainage could have come from the Fraser River via a possible connection between Moose Lake (Fraser River drainage) and the Miette River west of Jasper. Mountain whitefish and bull trout in the headwaters of the Bow River might well have moved across directly from the Columbia River drainage by way of a possible connection between the upper Kootenay and the Bow rivers near Vermilion Crossing and Radium Hotsprings (this is considered more probable than movement in the Kickinghorse Pass area); those in the Oldman River drainage might have used the Crowsnest Pass by moving up the Kootenay and Elk rivers into Michel Creek and thence into the Oldman River drainage via the Crowsnest River. Alternately, and perhaps more probable, those in the South Saskatchewan River drainage could have had only one crossing, the Crowsnest Pass being the easiest, and dispersed down, for example, the Oldman River and thence up to the Bow River. Mountain whitefish, therefore, probably had multiple crossings of the Rocky Mountains. Its occurrence in the North Saskatchewan River, however, might best be explained by postulating a movement via Glacial Lake Edmonton from the Athabasca drainage or from the South Saskatchewan River (which assumes that at some time past it moved down the South Saskatchewan River then up the North Saskatchewan River; those in the Red Deer River probably used the downstream-upstream route from the South Saskatchewan River). Bull trout, cutthroat trout, and pygmy whitefish in southwestern Alberta probably used a Kootenay-Bow, a Kootenay-Oldman, or by headwater capture, a Flathead-St. Mary crossing or have come from the Missouri River via the Milk River (or, of course, used more than one crossing). Longnose dace, lake chub, and longnose sucker may also have gained access into western Alberta from the Columbian refugium, but we believe that the Missouri-Mississippi area was the main refugium of these species for Alberta.

The Yukon refugium (sometimes called the Beringia refugium) was the least important and perhaps only the Arctic lamprey, Arctic

grayling, and round whitefish gained access to Alberta only from there. The Arctic grayling, once present in southwestern Alberta, probably had an additional refugium, namely in the Missouri River drainage. Eight other species in Alberta whose occurrence here is best explained by a Missouri-Mississippi refugium also had a Yukon refugium; how many also made it from there into Alberta is uncertain. Northern populations which might have come from the Yukon drainage, in general order of decreasing probability, are as follows: burbot, northern pike, slimy sculpin, trout-perch, lake trout, longnose sucker, lake chub, and lake whitefish.

As noted above, there was probably movement of at least some fish species into Alberta during the nonglacial Middle Wisconsinan, but whether or not they survived in the province during the Late Wisconsinan is open to speculation (if so, there was probably a subsequent movement into the province of individuals of many of the same species following full retreat of Late Wisconsinan ice). Evidence presented in Crossman and McAllister (1986) for a refugium in the Jasper-Banff area (e.g., for the Banff hotspring longnose dace and the Jasper area rainbow trout and longnose sucker) and in southwestern Alberta to us supports the hypothesis that some species had an early arrival from one of the major Wisconsinan refugia. However, it is difficult to differentiate between morphological distinctiveness of certain populations as being evidence of early arrival versus rapid evolution in a particular environment. We favor the view that there was not a continuous refugium for fish in Alberta during the last ice age and that a reinvasion of all fish species occurred in the last 13,000 or so years; this is supported by the data of Rains et al. (1990). Perhaps the unusually wide western distribution of the white sucker, which probably only had a Missouri-Mississippi refugium, is a result of it having early entry to the province and dispersing westward into Fraser and Skeena drainage just after retreat of the Late Wisconsinan ice. Also, it may have been possible for fish to have dispersed in runoff under the glacial ice before 13,000 years ago, but it is hard to imagine conditions being suitable for feeding and reproduction. Whether or not some plants or aquatic invertebrates (Clifford and Bergstrom 1976; Harris and Hubricht 1982) might have survived the last glaciation in Alberta is, however, another question.

The above is an overview of how our fishes might have gained access to the province after the ice age. A more detailed analysis could be made to explain local distributions (for example, in the landlocked kettle-hole

lakes near Edmonton, lakes at relatively high elevation such as Goldeye Lake, and bodies of water in the karst topography region of Wood Buffalo National Park described in Nelson and Paetz 1972, 1974). Clearly, the fish at any one locality, either a lake or a stream, are not a random nor a complete representation of all fish that had access to the general area. One must also examine factors of competition and environmental requirements in determining local assemblages (e.g., Robinson 1988; Robinson and Tonn 1989). On a broader scale, new approaches in molecular biology hold promise of resolving questions of refugial origins and time of separation of various lineages.

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5 The Species Concept, Classification, and Checklist

THE BASIC UNIT we deal with in biology is the species, and each species is unique. Furthermore, populations of species may differ from one another as may each individual differ from other individuals. This section deals with our understanding of what a species is, the mechanisms that prevent species from interbreeding with one another, the relatively rare cases of interbreeding between species (hybridization), our concept of genera, common and scientific names, families, and classification. Finally, all fish species from Alberta are listed.

5.1 Species

The biological species concept holds that a species consists of groups of interbreeding individuals which are capable of successfully interbreeding with other such groups in the species but which do not successfully interbreed with individuals of other species. For example, all individuals of the yellow perch can successfully interbreed with one another, but not with walleye. Thus, species represent different kinds of organisms. The existence of different species and our ability to recognize them results from their adaptation to different environments and their failure to grade into one another through free interbreeding. Although it is to be expected that there should be a gradation in going from one species to another in time or in the formation of two or more species from an ancestral one, we can have a concept of what a species is. We usually recognize different species by the extent of morphological differences between them, differences that we infer indicate a lack of interbreeding. Virtually all species exhibit some variation in their features (= characters) throughout their range. This is referred to as

intraspecific or geographic variation. For example, lake whitefish in Touchwood Lake have 23–28 (mean 26) gillrakers on their first gill arch while those in Cold Lake have 25–31 (mean 28); the total variation in the number of gillrakers for all studied populations of this species is 1933. The color of northern pike varies considerably from lake to lake. Differences may also occur in some features within an individual as it grows (e.g., color in northern pike; relative eye size in most species) and between the sexes at spawning time (e.g., body color, presence or absence of tubercles, and pelvic fin shape in longnose sucker).

5.2 Isolating Mechanisms

Reproductive isolation results from individuals having biological properties which prevent them from successfully interbreeding with other individuals. In fishes the isolating mechanisms are as follows:

Premating isolating mechanisms—those that prevent breeding from occurring between species:

1. Temporal—differences in time of spawning (e.g., spawning in the spring during increasing daylight versus spawning in the fall during decreasing daylight; spawning early in spring below 12°C versus spawning late in spring above 12°C).
2. Habitat—differences in place of spawning (e.g., spawning under overhanging objects versus over gravel).
3. Ethological (behavioral)—where, given a choice, an individual selects a mate of the same species and rejects others.

Postmating isolating mechanisms—those that act after breeding occurs between species:

4. Gamete incompatibility and hybrid embryo mortality—gametes between species do not fuse or embryo dies before hatching; generally, in fishes, related species can be easily crossed artificially and the embryos hatch successfully.
5. Hybrid inviability and sterility—the hybrid dies prematurely after hatching or is sterile.
6. Ineffective hybrid reproduction—the hybrid is fertile but does not reproduce under natural conditions (or first generation hybrids reproduce but subsequent hybrid generations do not).

Isolating mechanisms may vary in their effectiveness in different parts of the range of a species. For example, longnose suckers spawn before white suckers and in colder water in the Prince George region of British Columbia, but in southern Alberta they appear to spawn at about the same time.

Being geographically isolated from other individuals is not the same as being reproductively isolated; that is, geographic isolation is not an isolating mechanism. Geographic isolation is not a biological property of the individuals. We do not consider walleye from near Red Deer to belong to a different species than those from near Fort Vermillion. They cannot interbreed because of geographic separation, but we believe that they would freely interbreed if they should come together. It is thought, however, that a period of geographic isolation is normally a prerequisite for speciation in sexually reproducing animals. That is, effective isolating mechanisms normally only appear to develop after there has been a period of time of no gene flow between populations such that sufficient differences evolve that the forms will not successfully interbreed if they come together.

5.3 Hybridization

Some species do occasionally interbreed or hybridize with closely related species. However, such interbreeding does not lead to a breakdown of the genetic integrity of the groups, and if it did we would not usually continue to recognize the forms as separate species. For example, lake chub and longnose dace produce hybrids as do longnose and white suckers in the Kananaskis system, white suckers and largescale suckers hybridize in the Peace River system, and lake whitefish and cisco hybridize in many Alberta lakes. These hybrids need not be sterile, but generally they do not reproduce in nature and thereby they do not take over from the parental species; such interbreeding is therefore not considered as successful. Rainbow and cutthroat trout seem to readily hybridize when one is introduced into the range of the other, as in parts of Bow River system or when both are introduced together (e.g., McLean Lake, near Whitehorse, Yukon Territory—this population was eradicated, at least in part, in 1960). Rainbow-cutthroat hybrids reproduce and form a reproducing hybrid population. This suggests that these two species, or at least some forms of them that have been placed together, are very closely related and perhaps marginal as good biological species. Occasionally hybrids are intentionally produced for

fish cultural purposes. For example, splake, a fairly popular sports fish, are hybrids of brook trout and lake trout.

5.4 Genera and the Common and Scientific Name

All our fishes have both a common and a scientific name. Each name has its advantages and disadvantages. Both names can be used with precision and accuracy, and both can be misused as when falsely implying an accurate identification. Some users of scientific names may frown upon the use of common names and visa versa. Most people are not "afraid" to use common names, but there is the misguided view by some that the general public cannot or should not know or use scientific names. Certainly this is nonsense; every school child knows and uses the scientific name of dinosaurs and such children are not being pompous nor do they find the names stuffy or intimidating. Whatever one uses, its good to know something of both types of names. We present information on both in the rest of this section.

Species that are considered to be relatively closely related, usually because of their similar shape and anatomy (or preferably, because of their sharing evolutionarily derived features), are placed in the same genus (plural genera), the highest category that forms part of the scientific name. Thus the genus *Salmo* includes the true Atlantic trout, all of which share certain common characteristics. The generic name shows relationships by classifying the species. In contrast, common names often tell us nothing of relationships or may actually suggest false relationships. For example, Atlantic salmon and brown trout are relatively closely related species of the genus *Salmo* while brook trout and bull trout are much more closely related to the Arctic char than they are to any species of *Salmo* (the latter three species are placed in the genus *Salvelinus*). Common names are usually more stable than scientific names, in part, because as our views change on relationships with new information we may change species from one genus to another (although some people feel that common names should also indicate relationships and hence brook and bull trout would be changed to brook and bull char). Ideally, genera and other categories should combine species sharing a common ancestry and should contain all species derived from the common ancestor. However, when should a group or lineage be given, for example, the rank or status of subgenus, genus, tribe, subfamily, or family? There are no rules on how much of a morphological difference is necessary to designate various levels of

taxonomic rank. It is entirelya matter of opinion, and it is common for research workers to have differences of opinion on this matter. As a consequence, fish taxonomists may assign species to different genera. For example, all workers agree that bull trout and brook trout share more characters in common with one another than either do with lake trout. This evidence is used by some to support placing the lake trout in a separate genus, namely *Cristivomer*. The majority of workers, however, feel it more important to indicate relationships through generic names as much as practical, and place the above three species of char in the same genus, namely *Salvelinus*.

In contrast to the subjective matter of "splitting" and "'lumping," changes in genera can occur as a result of changes in ideas of evolutionary relationship. For example, it is generally agreed that the Pacific trout such as rainbow and cutthroat trout share a common ancestry with the Pacific salmon (*Oncorhynchus*) and not with Atlantic salmon and brown trout (*Salmo*). For this reason, most workers now place the Pacific trout in the genus *Oncorhynchus*. Unfortunately, such a move makes the construction of a simple generic key to salmonids very difficult. Another possible course of action would be to place the Pacific trout in their own genus.

The Latinized scientific name of a species in binominal nomenclature is a two-part name; it is a binominal consisting of a generic name and a specific name and it is employed throughout the world. The generic name is given first and its first letter is always capitalized. If a species is not considered to have any close evolutionary relationship with any other known species it may be the only species placed in a genus. Such a genus, to which only one species has been assigned, is said to be monotypic in contrast to a polytypic genus such as *Salvelinus* which has many species. The second or specific name always begins with a letter in lower case. The spelling of the specific name can vary because of certain rules in grammar if the species is placed in a different genus. For example, the lake chub may be *Couesius plumbeus* or *Hybopsis plumbea*. Together, the generic and specific names comprise the species name (to emphasize this point—*plumbeus* is not a species name; the term *plumbeus* can be used for numerous different animal species, but there can only be one animal species *Couesius plumbeus*). This name, unlike names of the higher categories such as family and order, is usually printed in italics (or the name is underlined to indicate italics). As a convention, it is appropriate to abbreviate the generic name to its first letter, as in writing *C. plumbeus*, if there is no other genus

beginning with the same letter between its first mention and the subsequent abbreviated mention. A third or subspecific name is sometimes employed for species with particular types of variation in their morphology in different areas.

Different common names often exist in different areas for the same species. This presents no problem when there is no communication between people employing the different "language," but uniformity in names is obviously desirable. Two examples will show the potential problem. In Alberta and in other areas walleye are commonly called "pickerel" (but "pickerel" properly refers to certain members of the pike family—e.g., chain, redfin, and grass pickerel of eastern Canada and United States) and northern pike are called "jacks" or "jackfish" (but "jack" is also used to describe a member of the marine family Carangidae or refer to a precocious male Pacific salmon). It is obviously advantageous to have one acceptable common name for each species so that individuals need not learn numerous synonyms to communicate with others and to avoid the danger of misunderstanding. In hopes of bringing about stability and uniformity in names, the American Fisheries Society and the American Society of Ichthyologists and Herpetologists have a list (Robins et al. 1991) of common and scientific names for fish in Canada and the United States.

Each species has an author, the person who first adequately described the species and named it under the rules of binominal nomenclature. An author's name is indicated, as is done in the text of this book at the start of each species account, by placing the author's surname after the species name. If the author originally described the species in a genus other than that in which it is now recognized, the author's name is placed in parentheses. Thus *Salvelinus namaycush* (Walbaum) means that the specific or trivial name *namaycush* was placed originally in a different genus by Walbaum.

Changes in the scientific name of a species is a source of frustration to all, but it is sometimes necessary under the rules of zoological nomenclature. A generic name is changed when it is discovered that it has been used earlier for another group of animals. For example, up to the early 1960s workers placed the brook stickleback in the genus *Eucalia*. However, this name had been used for a butterfly before it had been used for the fish. Since a generic name cannot be used for two different animals, the fish name had to be changed. In this case, *Culaea* was adopted as a generic name.

A note on pronunciation of scientific names—the first reaction of many people is to stay clear of trying to pronounce these names to themselves, let alone trying to use them in conversation. Although there is normally no reason why the scientific name should be used in place of the common name in ordinary conversation, there is no reason either why people should not feel comfortable in using such names even though Greek or Latin may not have been part of their education. Also, it is easier to remember how to spell the names if they are pronounced. It must be acknowledged that biologists do differ in pronouncing many names and regional and individual differences do exist (e.g., Co-re-**go**-nus vs Cor-**eg**-onus and Ca-to-**sto**-mus vs Cat-**ost**-omus; in each case the latter is smoother but not the preferred way to reflect the roots of the word). It is because of the fear that many people have in trying to pronounce these names and the great variation when no guidelines are used, thereby hurting clear communication, that we present this material.

A few simple rules will at least get the beginner going with pronunciation so that others can understand what is being said (this, after all, is the basic reason for having a reasonably consistent pronunciation of words—especially if communicating with someone whose language is not English). Aquarists who read the "Freshwater and Marine Aquarium" magazine will be familiar with pronouncing scientific names through articles by Walt Maurus entitled "The Piscatorial Verbiphile." We hasten to add that this section is written as a guide as to how many native English speakers use the words, not necessarily as someone in classics would argue how they should be pronounced in Latin. Readers wishing to take the subject of pronouncing Latinized names more seriously may wish to consult a scholar in classics or an appropriate book.

As a start, establish syllables with one vowel in each. There may be 0-3 consonants in a syllable but a typical pattern, except for the last syllable, is one consonant/one vowel. Break double consonants between syllables and place the emphasis on the second last syllable. Here are some examples of genera of Alberta fishes. Say them out loud and try experimenting with new names; do not be afraid of making a "mistake." *Salmo* = Sal-mo; *Percopsis* = Per-cop-sis. If the first letter is a vowel, first try to pronounce it with that letter forming the first syllable (if that does not sound pleasing then try putting it with the first consonant): thus *Acipenser* = A-ci-pen-ser (here, the "c" is pronounced by many people as a "k" as in "Canada"; technically, in classical Latin, "c" and "ch" are pronounced as "k" but we are generally more flexible

than this with some Latinized words; i.e., native English speakers may tend to anglicize the words as in pronouncing "centipede" with an "s" rather than "k" sound). Now try *Phoxinus*. Here, the first two letters are adjacent consonants so they cannot make a syllable. It is Phox-in-us with the "ph" sounding like an "f" as in "photograph" and the accented syllable takes a long vowel "i" (so most biologists would pronounce it like fox-**in**-us). Note that for those names commemorating a person (patronyms or matronyms), the most appropriate pronunciation would be according to how the person's name is pronounced (thus *Couesius* = Coues-ius, pronounced as "Cows-ius" vs "Cou-es-ius").

5.5 Families and Classification

Different genera which are considered to be relatively closely related are combined into the same family. Thus, the genera comprising Arctic grayling, whitefish, and trout are placed in the same family, Salmonidae. A large number of species may be placed in the same family if a great deal of speciation has resulted among similar appearing forms. The family of minnows thus contains about 2,000 species, and it is probably the largest family of the vertebrates. On the other hand, the family of trout-perch contains only two species.

Subfamilies may be recognized if we wish to combine relatively closely related genera at a lower level than family. Thus, trout, char, and Pacific salmon are placed in a separate subfamily from whitefishes; Arctic grayling are placed in their own subfamily. There is a certain amount of subjectivity in determining rank and some authors may variously give family rank to what others give subfamily rank (e.g., Coregonidae vs Coregoninae). These workers may agree on the relationships of the groups involved but differences of opinion as to what constitutes a subfamily versus a family does cause confusion for beginning students of taxonomy.

Related families are placed in the same order, related orders in the same class, and related classes in the same phylum (numerous other categories, usually with the prefix sub- or super-, are also often used). All native (indigenous) living Alberta fish species, representing 13 families, 11 orders, and two classes belong to the phylum Chordata and subphylum Vertebrata. The two fish classes in Alberta are Cephalaspidomorphi and Osteichthyes. The other classes of living Alberta members of the subphylum Vertebrata are the classes of

tetrapods, namely, the Amphibia (amphibians—frogs, toads, and salamanders), Reptilia (reptiles—turtles, snakes, and lizards), Aves (birds), and Mammalia (mammals). Other classes of fish are represented in the province by fossils.

The object of a biological classification is to show evolutionary relationships. We do this in a hierarchical system by assigning various taxa (singular "taxon") ranks. Taxa are the groups that are given biological names (e.g., *Salmo* and Salmonidae) and the category is the level or rank at which the taxon is placed (e.g., genus and family). Further details of fish classification may be found in Nelson (1984).

Here is a relatively detailed classification of three common Alberta fish species:

CATEGORY	NORTHERN PIKE	BURBOT	YELLOW PERCH
PHYLUM	Chordata	Chordata	Chordata
SUBPHYLUM	Vertebrata	Vertebrata	Vertebrata
CLASS	Osteichthyes	Osteichthyes	Osteichthyes
SUBCLASS	Actinopterygii	Actinopterygii	Actinopterygii
SUBDIVISION	Teleostei	Teleostei	Teleostei
SUPERORDER	Protacanthopterygii	Paracanthopterygii	Acanthopterygii
ORDER	Salmoniformes	Gadiformes	Perciformes
SUBORDER	Esocoidei	Gadoidei	Percoidei
FAMILY	Esocidae	Gadidae	Percidae
GENUS	*Esox*	*Lota*	*Perca*
SPECIES	*Esox lucius*	*Lota lota*	*Perca flavescens*

5.6 Checklist of Alberta Fishes

This list includes species that have been reported from Alberta and that probably have established self-sustaining populations in the province. It includes native (N) and introduced (I) species, but it excludes those species given in Appendix I which have been introduced or collected in Alberta but appear not to be established and those species found in adjacent areas, some of which may eventually be found in Alberta.

The scientific and common names of the species follows Robins et al. (1991). The names of higher categories and their phylogenetic arrangement follows Nelson (1984). For a complete list of fishes in Canada see McAllister (1990).

		STATUS
Class Cephalaspidomorphi—higher jawless fishes		
Order Petromyzontiformes		
Family Petromyzontidae—lampreys		
Lampetra japonica (Martens)	Arctic lamprey	N
Class Osteichthyes—bony fishes		
Order Acipenseriformes		
Family Acipenseridae—sturgeons		
Acipenser fulvescens Rafinesque	lake sturgeon	N
Order Osteoglossiformes		
Family Hiodontidae—mooneyes		
Hiodon alosoides (Rafinesque)	goldeye	N
Hiodon tergisus Lesueur	mooneye	N
Order Cypriniformes		
Family Cyprinidae—minnows		
Couesius plumbeus (Agassiz)	lake chub	N
Hybognathus argyritis Girard	western silvery minnow	N
Hybognathus hankinsoni Hubbs	brassy minnow	N
Margariscus margarita (Cope)	pearl dace	N
Notropis atherinoides Rafinesque	emerald shiner	N
Notropis blennius (Girard)	river shiner	N
Notropis hudsonius (Clinton)	spottail shiner	N
Phoxinus eos (Cope)	northern redbelly dace	N
Phoxinus neogaeus Cope	finescale dace	N
Pimephales promelas Rafinesque	fathead minnow	N
Platygobio gracilis (Richardson)	flathead chub	N
Ptychocheilus oregonensis (Richardson)	northern squawfish	N
Rhinichthys cataractae (Valenciennes)	longnose dace	N
Richardsonius balteatus (Richardson)	redside shiner	N
Family Catostomidae—suckers		
Subfamily Ictiobinae		
Carpiodes cyprinus (Lesueur)	quillback	N
Subfamily Catostominae		
Catostomus catostomus (Forster)	longnose sucker	N

		STATUS
Catostomus commersoni (Lacepède)	white sucker	N
Catostomus macrocheilus Girard	largescale sucker	N
Catostomus platyrhynchus (Cope)	mountain sucker	N
Moxostoma anisurum (Rafinesque)	silver redhorse	N
Moxostoma macrolepidotum (Lesueur)	shorthead redhorse	N
Order Siluriformes		
Family Ictaluridae—bullhead catfishes		
Noturus flavus Rafinesque	stonecat	N
Order Salmoniformes		
Family Esocidae—pikes		
Esox lucius Linnaeus	northern pike	N
Family Salmonidae—trouts		
Subfamily Coregoninae		
Coregonus artedi Lesueur	cisco	N
Coregonus zenithicus (Jordan and Evermann)	shortjaw cisco	N
Coregonus clupeaformis (Mitchill)	lake whitefish	N
Prosopium coulteri (Eigenmann and Eigenmann)	pygmy whitefish	N
Prosopium cylindraceum (Pallas)	round whitefish	N
Prosopium williamsoni (Girard)	mountain whitefish	N
Subfamily Thymallinae		
Thymallus arcticus (Pallas)	Arctic grayling	N
Subfamily Salmoninae		
Oncorhynchus aguabonita (Jordan)	golden trout	I
Oncorhynchus clarki (Richardson)	cutthroat trout	N
Oncorhynchus mykiss (Walbaum)	rainbow trout	N
Salmo trutta Linnaeus	brown trout	I
Salvelinus confluentus (Suckley)	bull trout	N
Salvelinus malma (Walbaum)	Dolly Varden	I
Salvelinus fontinalis (Mitchill)	brook trout	I
Salvelinus namaycush (Walbaum)	lake trout	N

		STATUS
Order Percopsiformes		
Family Percopsidae—trout-perches		
Percopsis omiscomaycus (Walbaum)	trout-perch	N
Order Gadiformes		
Family Gadidae—cods		
Lota lota (Linnaeus)	burbot	N
Order Cyprinodontiformes		
Family Poeciliidae—livebearers		
Gambusia affinis (Baird and Girard)	western mosquitofish	I
Poecilia latipinna (Lesueur)	sailfin molly	I
Order Gasterosteiformes		
Family Gasterosteidae—sticklebacks		
Culaea inconstans (Kirtland)	brook stickleback	N
Gasterosteus aculeatus Linnaeus	threespine stickleback	I
Pungitius pungitius (Linnaeus)	ninespine stickleback	N
Order Scorpaeniformes		
Family Cottidae—sculpins		
Cottus cognatus Richardson	slimy sculpin	N
Cottus confusus Bailey and Bond	shorthead sculpin	N
Cottus ricei (Nelson)	spoonhead sculpin	N
Myoxocephalus thompsoni (Girard)	deepwater sculpin	N
Order Perciformes		
Family Percidae—perches		
Etheostoma exile (Girard)	Iowa darter	N
Percina caprodes (Rafinesque)	logperch	N
Perca flavescens (Mitchill)	yellow perch	N
Stizostedion canadense (Smith)	sauger	N
Stizostedion vitreum vitreum (Mitchill)	walleye	N
Family Cichlidae—cichlids		
Hemichromis bimaculatus Gill	African jewelfish	I

6 Fish Species in Alberta, Evolution, and Fossils

6.1 Numbers of Species and Families

The 59 species of Alberta fish with self-perpetuating populations are classified into 15 families (13 of which are indigenous or native) (Table 6.1a). These numbers are relatively low compared to the figure of world fishes, namely, some estimated 21,800 valid described species and 445 families (Nelson 1984).

The numbers of fish species in Alberta (51 native species) is also relatively low compared to the numbers of our birds and mammals. The pie-diagrams in Fig. 6.1a indicate the relative number of species in the five major groups of vertebrates for the World, Canada, and Alberta. McAllister (1990) lists 1102 species of fishes known from Canadian inland and marine waters, slightly different from the number used in the pie-diagram. The greatest discrepancy between the relative number of species in the world and in Alberta is the local paucity in fishes and reptiles and the abundance of bird species. However, if only resident birds were considered then birds would not be disproportionately more abundant (all of the fish and probably all amphibians, reptiles, and mammals are year-round residents whereas most birds are not). The relative paucity of our fish species (and probably of our species of amphibians—two salamanders, four frogs, and four toads; and reptiles—one turtle, one lizard, and six snakes) is related, in part, to the headwater nature of our drainages and distance from glacial refugia. We have no endemic species (species which are confined to a given area) of vertebrates in Alberta and only a few in Canada (unlike such countries as Australia, New Zealand, and the United States).

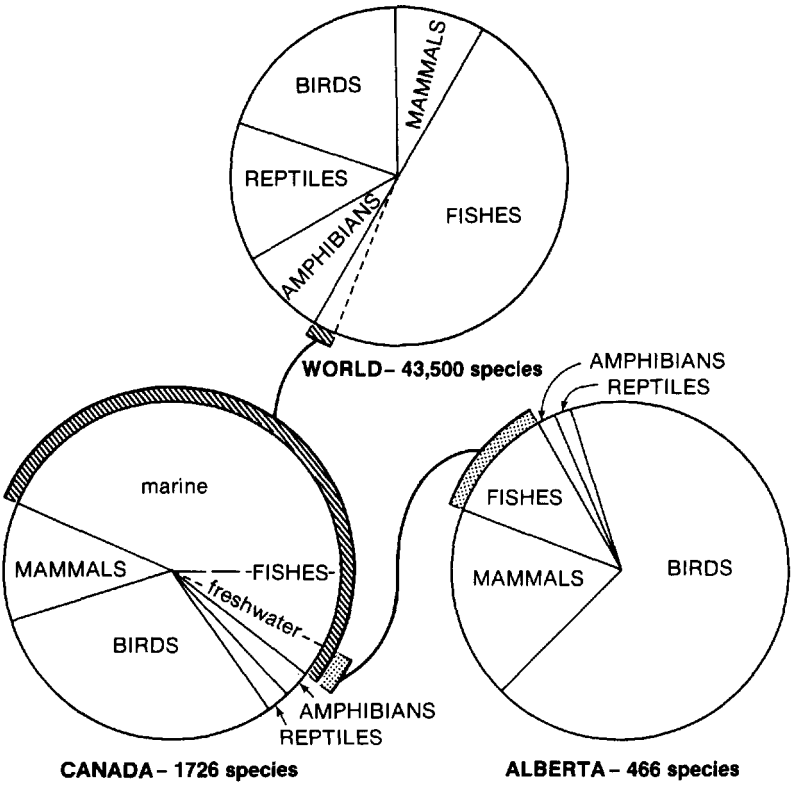

Fig. 6.1a Relative number of living species of fishes (superclass Agnatha and classes Chondrichthyes and Osteichthyes), amphibians (class Amphibia), reptiles (class Reptilia), birds (class Aves), and mammals (class Mammalia) for the world, Canada (native), and Alberta (native) (marine species are included for Canada and the world) (modified and revised from Nelson 1979). The species number refers to the number of native vertebrates in the indicated geographic region.

Table 6.1a The following table gives the numbers of fish species in our 15 families (Note—another species, the prickly sculpin, known from one specimen, may be part of the native fauna).

Family	Number of native species	Number of introduced species	Total for Alberta	Percent for Alberta
Trout—Salmonidae	11	4	15	25.4
Minnow—Cyprinidae	14	0	14	23.7
Sucker—Catostomidae	7	0	7	11.8
Perch—Percidae	5	0	5	8.5
Sculpin—Cottidae	4	0	4	6.8
Stickleback—Gasterosteidae	2	1	3	5.1
Mooneye—Hiodontidae	2	0	2	3.4
Livebearer—Poeciliidae	0	2	2	3.4
Pike—Esocidae	1	0	1	1.7
Cod—Gadidae	1	0	1	1.7
Trout-perch—Percopsidae	1	0	1	1.7
Bullhead catfish—Ictaluridae	1	0	1	1.7
Sturgeon—Acipenseridae	1	0	1	1.7
Cichlid—Cichlidae	0	1	1	1.7
Lamprey—Petromyzontidae	1	0	1	1.7
Totals	**51**	**8**	**59**	**100%**

6.2 Evolution of Alberta Fish Families and Fossils

The fishes in Alberta represent a wide range of evolutionary diversity. Fig. 6.2a shows, in general diagrammatic form, the evolutionary or phylogenetic relationships of the 15 families in the province.

There is an extensive fossil fish fauna in the province (Fig. 6.2b). The oldest known ones were here about 400,000,000 years ago. The fossils include forms from the following groups: placoderms such as *Coccosteus* and *Bothriolepis* from the Devonian; holocephalans, including Jurassic forms related to modern chimaeras; sharks and rays (related to sawfish and stingrays) from the Upper Cretaceous; lungfishes from the Upper Devonian; crossopterygians from the Upper Devonian and Lower Triassic; a variety of chondrosteans from the Lower Triassic and

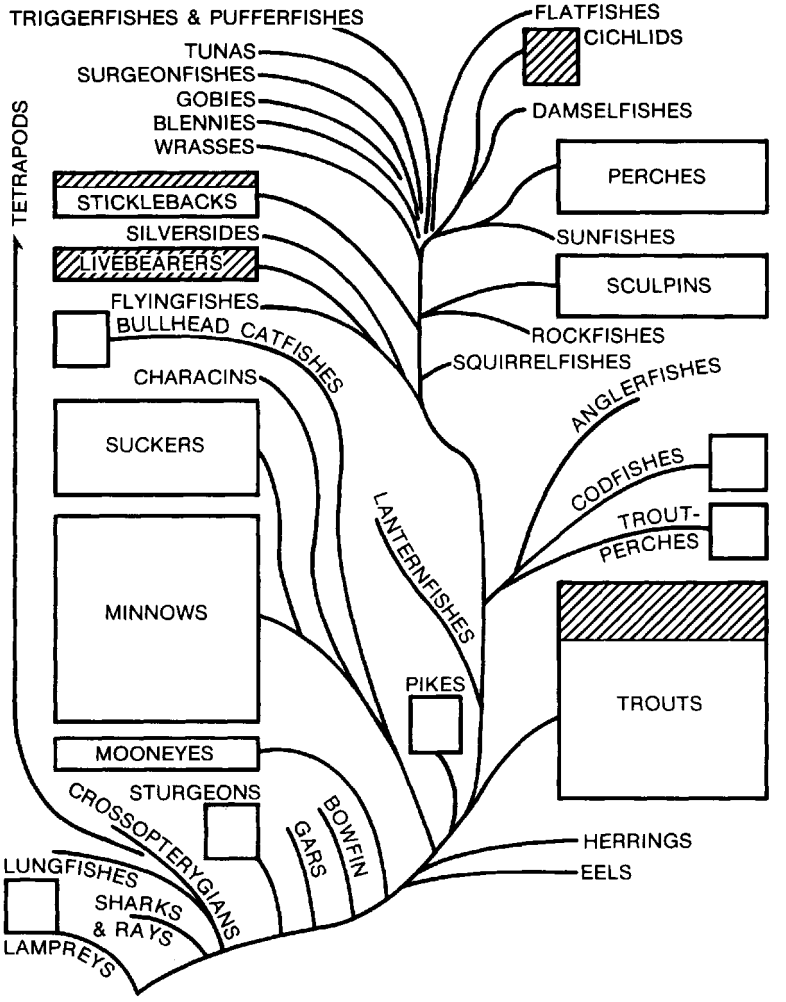

Fig. 6.2a The postulated evolutionary relationships in generalized diagrammatic form of Alberta fish families (shown as blocks) along with that of some other major groups (names only). All lines indicating postulated relationships are shown as the same regardless of whether the affinity is considered highly speculative or relatively certain. The distance between branching points is not intended to indicate the inferred amount of evolutionary divergence between the lineages. The area of the blocks is proportional to the number of species in Alberta recognized in the indicated group; the white area represents the percentage of species that are native, the black area those that have been successfully introduced. (Modelled after Nelson 1984: p. 89).

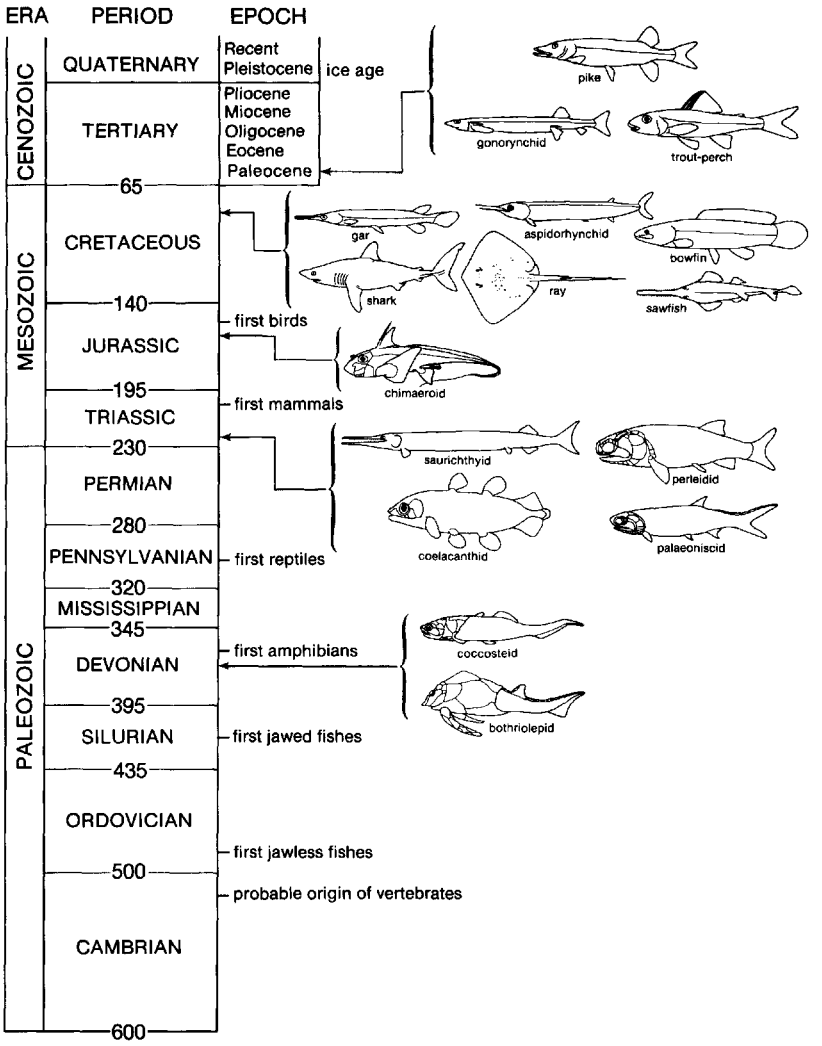

Fig. 6.2b Geological time scale with some representative fossil fish of major groups known from Alberta shown in outline form and major events of vertebrate evolution on a world scale shown in statement form. Approximate age between boundaries in millions of years. The Pennsylvanian and Mississippian are sometimes recognized as the Upper and Lower Carboniferous respectively. The diagrams are intended to show only representatives of groups found in Alberta. Some groups are known from a considerable time span and the arrows denoting time of occurrence are not intended to imply restriction to that time period. Some of the species, especially the chimaeroids, are known in the province only from small fragments and consequently their general shape is unknown.

Lower Jurassic including Upper Cretaceous sturgeon; relatives of modern gar and bowfin and some marine aulopiforms, known primarily from the Upper Cretaceous; a large variety of Paleocene teleosts, such as osteoglossids, gonorynchids, esocids (the fossil pike in Alberta is the oldest known one in the world), and percopsids (Gardiner 1966; McKenzie and Bamber 1979; Neuman and Wilson 1985; O'Brian 1969; Storer and Johnson 1974; Thomson 1967; Wilson 1980, 1984; Wilson and Chalifa 1989; Wilson and Williams, 1991). Many of the fossils are known in Alberta only from small fragments such as teeth and scales (e.g., many sharks and rays are known from Cretaceous beds, some belonging to genera with extant or living species, but are known largely from teeth and "scales"). The fishes lived in i) extensions of the Pacific Ocean (which inundated parts of Alberta many times up into the Jurassic period), ii) a vast marine waterway which, for part of the Cretaceous, connected the Arctic Ocean with the Gulf of Mexico (it also became essentially landlocked as the Mowry Sea), and iii) freshwater lakes and streams. An active study of fossil fishes in Alberta by Dr. M.V.H. Wilson of the University of Alberta, his students, and colleagues (including those at the Royal Tyrrell Museum of Paleontology in Drumheller) is revealing many interesting new species. Pleistocene remains of a number of species, such as Arctic grayling, are also known.

Also of interest are fish remains found at fur trading posts (in refuse pits, etc.) or at other sites of early inhabitants of the province. For example, the remains of six species of fish have been reported in archaeological work from a site occupied next to the North Saskatchewan River southeast of Smoky Lake between 1810 and 1813 (Hurlburt 1977). Of particular interest is the find of bones of a catfish, *Ictalurus punctatus*, not presently found in the province. More information about the former occurrence of this species in Alberta is given under the description of the catfish family, Ictaluridae.

7 Maps, Keys, and Definitions

7.1 Distribution Maps

The distribution maps for each species of fish in the following chapters show the areas of occurrence of the species by two methods: locality records of verified or verifiable identifications of specimens to show known areas of occurrence, and shading to show probable areas of occurrence. The two methods serve different purposes. The locality records on the maps shown as black dots are based on specimens in the University of Alberta Museum of Zoology. In some cases, one dot serves for several nearby locations. In a very few cases a dot may represent a verified record but one for which we lack specimens. The shading indicates the probable general distribution of the species in the province; the boundary of the shading does not necessarily define actual limits. This is based on publications such as Henderson and Peter (1969) and Willock (1969a,b), government sponsored studies (primarily conducted by Alberta Environment and the Fish and Wildlife Division of Alberta Forestry, Lands and Wildlife), theses in the Department of Zoology of the University of Alberta, and on our expectations of where they should occur (i.e., in suitable habitat where no known barriers exist from known locality records). We emphasize that this indication of range does not mean that the species in question should occur throughout the area; it implies that the species might be expected to occur in suitable waters, if any exist, within the area indicated. Nor does it mean that the species does not exist outside the area; however, we would be interested to learn of any collections that represent range extensions.

The section on distribution of each species in the text contains a statement of the general range of the fish in the world and in the province.

7.2 How to Use the Keys

Keys are generally the best means of finding out what a certain organism is. Identification through the use of these keys may be facilitated by comparing the unknown specimen with the pictures of the species. Reliance on only comparing a specimen with a picture, however, is poor practice and often results in error. Consistent use of the keys will result in their mastery and give much satisfaction to the user and confidence in identifications.

If the family of a fish is not known, the user should start with the "Key to the 15 Families of Fishes of Alberta," Chapter 8. Following that, the species keys at the start of each family chapter should be used. The keys include only those families and species that are considered part of the established Alberta fish fauna.

The keys are designed to distinguish features so that an identification can be made by means of a series of alternative choices. To identify a fish, the user should examine the first two alternatives, determine which one best describes the specimen (A or B), and proceed to the next alternatives indicated by the number at the end of the correct alternative. Continue in this way through successive alternatives until a name is reached. If in a pair of alternatives it cannot be decided which one is correct then both alternatives should be followed; when a tentative identification is reached the descriptions in the text should be checked with the specimen and with the original troublesome choices (the user should consider the possibility that the specimen represents a species not given in the key). In many cases the first feature given in an alternative may be relied upon to reach a decision; if, however, a clear choice is not reached the other features should be used. The number in parentheses after the couplet number enables the user to retrace the path of alternatives quickly.

In identification one must keep in mind the wide variability of some characters due to the environment and due to actual genetic differences both between populations and between individuals of the same population. The amount of variation in a few species precludes a simple and unfailing key. When there is an overlap in some feature between two species for a small minority of the known specimens, we indicate in the key what the usual situation is by stating, for example, "dorsal fin rays usually 13 to 16."

An attempt has been made to include enough diagnostic characters so that mistakes at one alternative will not lead to incorrect identifications

and so that the key will be of use with specimens having a deformed feature. This also reduces the chance of failing to recognize a species new to the province. The comparative descriptions for each species in the text should help insure accurate identifications. The danger of misidentifying a species new to Alberta and thus not in the key can be further avoided by checking all questionable identifications with descriptions of species given in Appendix I, descriptions given in Brown (1971), Carl, Clemens, and Lindsey (1967), Hubbs and Lagler (1964), McPhail and Lindsey (1970), Moore (1968), and Scott and Crossman (1973), and by comparison with specimens previously identified by competent workers. Atton and Merkowsky (1983) give detailed distributional information on the fish fauna of Saskatchewan, the adjacent area with the most species unknown to Alberta that may occur here.

The keys are not intended for hybrids or larvae. Larval fish can often be identified, at least to family and often to genus. Features that are used in such identifications include length (relative to stage of development), number of myomeres, and pigmentation patterns. The extensive guide by Auer (1982), although designed for the Great Lakes, includes most of the Alberta species.

Fishes are relatively easy to identify in keys because they possess many characters which can be quantified. Some characters can be counted. These are called "meristic characters" and are serially repeated parts such as scales and fin rays. Other characters can be measured. These are the "morphometric characters" and they are usually expressed as ratios or fractions. Still other characters can be expressed in terms of presence or absence of a structure or by their color or color pattern. All such characters may have a genetic and a non-genetic (environmental) component determining their nature. That is, fish of identical genetical make-up may differ in number of vertebrae, relative head size, and in color if reared under differing conditions.

For the sake of brevity, some technical terms are used in the keys which relate to meristic and morphometric characters. Most of these terms are explained in the following section.

7.3 Definitions of Fish Characteristics

Counts of meristic characters given in the species key and general species description are from Alberta material, from regional works outside Alberta, and from recent systematic studies. The length of the longest known specimen is given as the maximum length. Unfortunately, it is

not always known whether the length was recorded as total, fork, or standard length. The maximum length for Alberta specimens sometimes represents the largest individual from a small collection and larger specimens no doubt exist. Many characters may be measured or counted in different ways. The methods recommended by Hubbs and Lagler (1964) are generally followed. Some of the technical terms used in the keys and methods of counting and measuring are mentioned below. Several features are shown in Figs. 7.3a-e.

adipose fin—a small fleshy rayless fin on the back between the dorsal and caudal fins in members of the trout, catfish, and trout-perch families.

anal fin—a median fin on the lower part of the body between the pelvic fins and the caudal fin.

anterior—the front part or in front of another part.

barbel—an elongate fleshy process near the mouth provided with the sense of touch or smell. Found in sturgeon, catfish, burbot, and some minnows.

basal end of a fin—the point where the most posterior ray joins the body.

basal length of a fin—the length of the fin where it is attached to the body; see Fig. 7.3a.

basibranchials—a series of median bones behind the tongue and between the gills.

branchiostegal rays—long curved bones supporting the gill (branchiostegal) membrane which encloses the gill chamber ventrally; they attach to the epihyal and ceratohyal bones.

caudal fin—the tail fin (see also *heterocercal* and *homocercal*).

caudal peduncle—the portion of the body between the end of the anal fin and the base of the caudal fin; see *scale counts* and Fig. 7.3a.

cheek—the area between the eye and preopercle bone (see Fig. 7.3a,b for this bone).

compressed—flattened from side to side.

concave—curved inward, like the inside of a circle.

convex—curved outward, like the outside of a circle.

ctenoid scale—a scale bearing tiny spines on its posterior portion and feeling rough to the fingers, typical of the perch family.

cycloid scale—a scale approximately circular in outline, lacking spines and relatively smooth to the fingers, typical of most Alberta fish.

decurved—curved downward.

depressed—flattened from top to bottom.

dorsal—pertaining to the back or upper side.

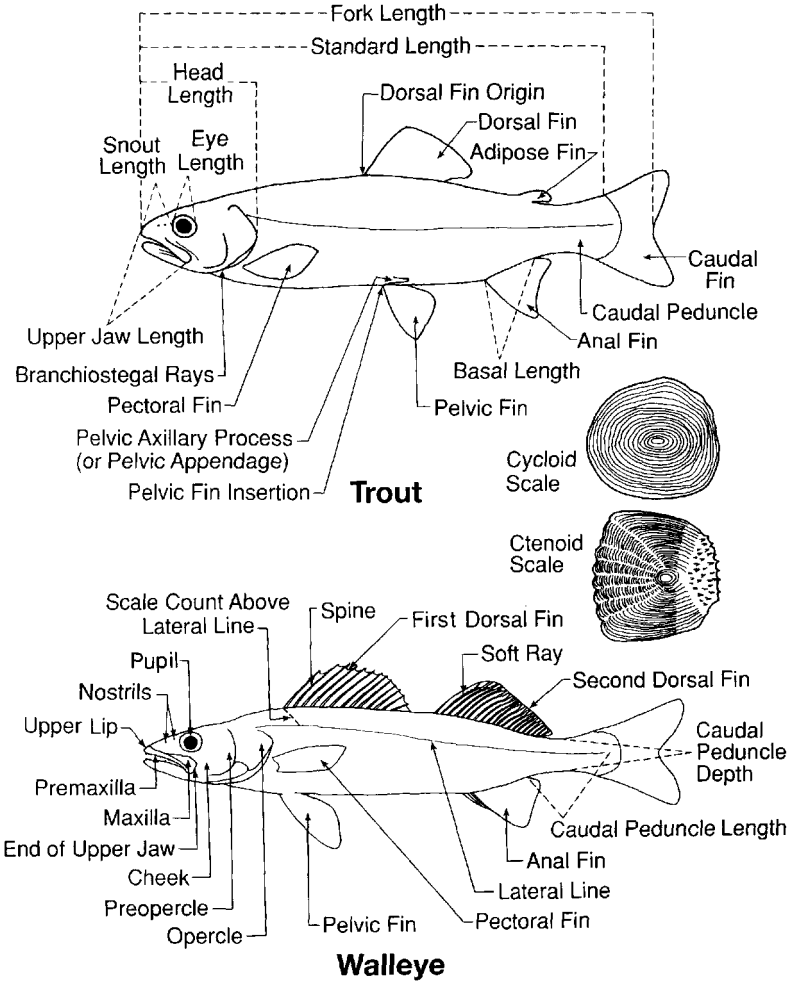

Fig. 7.3a Lateral view of two fishes showing some of the structures used in identification. The sites used in making some measurements are also shown. Note that the pelvic fin in the trout is in abdominal position whereas in the walleye it is thoracic.

eye length—the horizontal length of the exposed eye. This should not be confused with iris length (diameter) which is measured across only the pupil, or with orbit length (diameter) which is measured across the bony margins of the eye socket. It is sometimes referred to as the eye diameter, but this can mean the diameter of the entire eye ball. Eye length and eye diameter are used synonymously in this book.

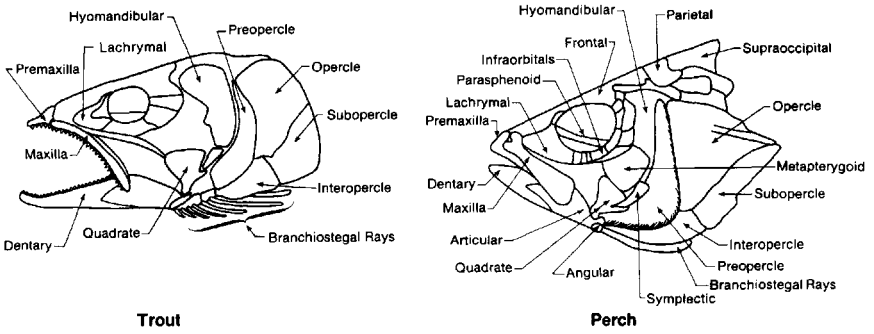

Fig. 7.3b Relationships of some of the skull bones (trout and perch). Many of these bones, whether found as remains in the stomach contents of another animal or found from other sources of mortality, may be used to identify the fish to family or, sometimes, to species.

falcate—scythe or sickle-shaped, with a concave margin; as in the trailing edge of the pectoral fin of flathead chub.

fork length (FL)—the straight line distance from the most anterior point of the snout to the central part of the margin of the caudal fin (whether forked or not).

frenum—a vertical bridge of tissue that crosses over a groove between the upper jaw and snout (the premaxillary groove) and connects the upper lip to the snout thus making the premaxillaries nonprotractile. Present in goldeye, mooneye, longnose dace, pike, salmonids, trout-perch, Iowa darter, and logperch.

gill cover—the operculum; the large thin bones on each side of the head that cover the gills. There are four opercular bones, the preopercle, opercle, subopercle, and interopercle, in each gill cover in most extant jawed fishes; see Fig. 7.3b.

gillrakers or *gill rakers*—the structures attached to the front margin of the gill arches (found beneath the gill cover), opposite the gill filaments; they are often slender rodlike projections although length and shape can vary between species; see Fig. 7.3c. Unless otherwise stated, counts are made on the first gill arch, which usually must be dissected out, and on the outside or external row if two rows are present.

gonad—the ovary or testis.

head length—the distance from the most anterior part of the head to the most posterior part of the opercular membrane.

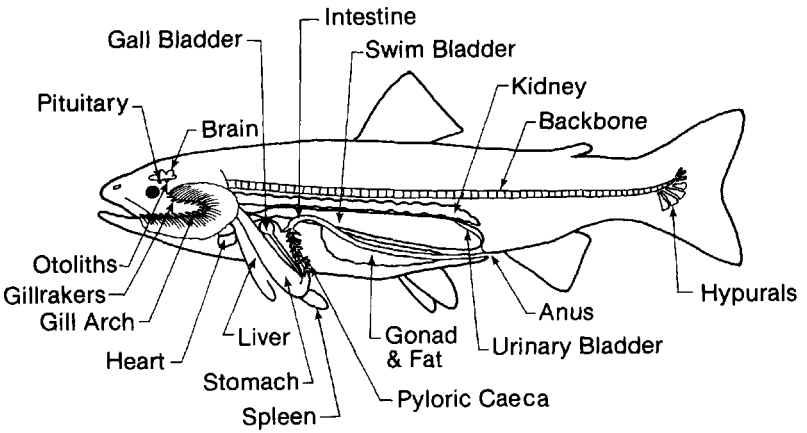

Fig. 7.3c Internal anatomy of a fish

heterocercal caudal fin—a tail fin in which the upper lobe has a distinct fleshy base and is longer than the lower lobe, as in the sturgeon.

homocercal caudal fin—a tail fin in which the upper and lower lobes are about equal or the fin is rounded; in all Alberta jawed fishes except the sturgeon.

hypural bones or plate—the modified spines that are beneath the vertebrae (the haemal spines) of the last few vertebrae on which the caudal fin-rays articulate; the end of the hypural plate is determined without dissection by moving the tail fin from side to side.

inferior or ventral mouth—a mouth in which the upper jaw or snout projects beyond the lower jaw as in sturgeon. The term "subterminal" is used for a mouth that is only modestly inferior, as in the longnose dace and most suckers.

insertion (of a fin)—an end at which the fin is attached to the body, the front end of paired fins such as the pelvic and the hind end of median fins such as the dorsal and anal fins.

isthmus—the ventral portion of the "head" behind the lower jaw and between the opercular flaps; see Fig. 7.3d.

kype—the elongated hook of the anterior tip of the snout and lower jaw developed in large breeding males of some trout, char, and salmon.

lateral—toward the side or on the side.

lateral line—a series of pores along the side, variously developed or absent.

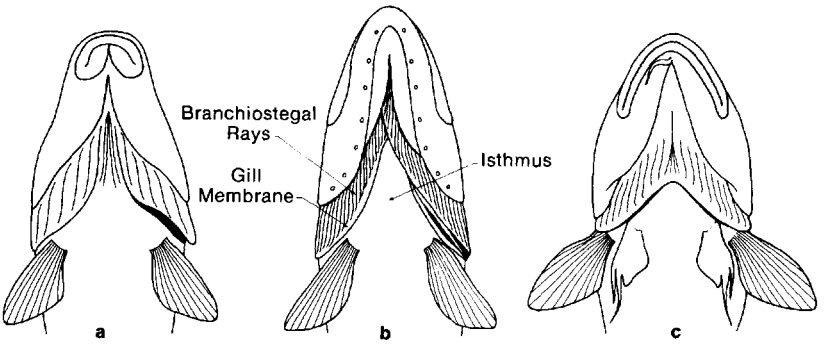

Fig. 7.3d Ventral view of the heads of three Alberta fishes showing the various means of gill membrane (or branchiostegal membrane) attachment.
a) Gill membranes united to isthmus and gill slits not extended far forward, white sucker.
b) Gill membranes free from isthmus, not attached to each other and gill slits extended far forward, northern pike.
c) Gill membranes broadly connected to each other with an underneath cavity, burbot.

maxilla—the bone of the upper jaw lying behind (as in salmonids) or above (as in percids) the premaxilla.

median—situated on the middle or axial plane (=midline).

meristic—any body part occurring in serial repetition; for example, scales, fin rays, and vertebrae.

nape—the part of the body on the dorsal surface above the first few vertebrae and immediately behind the head.

opercle or operculum—the large, flat, and thin bones on each side of the head covering the gills; see also *gill cover*.

origin (of the dorsal, adipose, and anal fins)—the most anterior point of attachment to the body.

palatine—a paired bone in the roof of the mouth lying on either side of the centrally located vomer and behind the premaxilla; see Fig. 7.3e.

papilla—a small fleshy projection.

papillose—covered with papillae.

parr marks—vertical dark bars on the sides of some young fish such as Arctic grayling, trout, char, and mountain whitefish.

pectoral fin—the anterior most, except in burbot, of the two paired fins; it is behind the head and either located ventrally or on the side.

pelvic fin—the paired fin lying beneath or behind the pectoral fin, always in front of the anal fin; the pelvic fin is sometimes called the ventral fin.

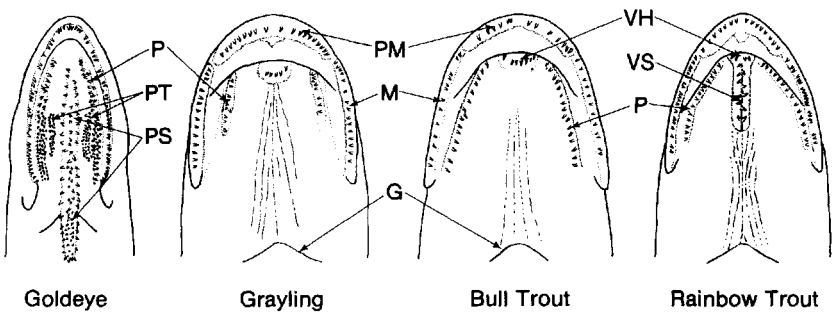

Fig. 7.3e View of roof of mouth in four Alberta fishes showing various tooth patterns. Drawings are made with the lower jaw removed and some details will not be seen by merely opening the fishes mouth; some teeth, particularly in the goldeye, require careful observation to see.
G-gill slit; M-teeth on maxillae; P-teeth on palatine; PM-teeth on premaxillae; PS-teeth on parasphenoid; PT-teeth on pterygoids (ectopterygoid and endopterygoid); VH-teeth at head of vomer or prevomerine teeth; VS-teeth on shaft of vomer.

peritoneum—the membrane lining the inside of the body cavity, seen by slitting open the fish ventrally.

pharyngeal teeth—toothlike projections on the fifth gill arch; see introductory section of Chapter 12 on the minnow family for details.

physoclistous—having lost the embryonic duct connecting the swim (air) bladder and the esophagus, generally the condition in spiny-rayed fishes such as perch.

physostomous—having a functional duct connecting the swim (air) bladder and the esophagus, generally the condition in soft-rayed fishes such as trout and minnows.

plicate—having a series of wrinklelike folds of skin (plicae).

posterior—that which is in the hind part or behind another part.

premaxilla—the bone at the anterior tip of the upper jaw; see Fig. 7.3e.

protractile—capable of being extended out as in the case of the upper jaw in fish lacking a frenum.

pseudobranch—an accessory gill on the inner surface of the opercle.

pyloric caeca—fingerlike outpocketings of the gut located where the intestine leaves the stomach; see Fig. 7.3c.

ray of a fin—splintlike supporting structures to the fin membranes, includes both soft-rays and spines.

scale counts

a) along lateral line—the number of scales along the lateral line or along its normal position and terminating at the base of the

caudal fin (end of hypural plate). Several variations of this count exist. In the salmonids often only the sensory pores along the lateral line are counted (which gives a lower count) or the scales one or two rows above the lateral line are counted (giving a higher count).

b) above the lateral line—the number of scales in a diagonal row from the origin of the dorsal fin, including any small scales, to, but not including, the lateral-line scale.

c) around the caudal peduncle—the circumference scale count around the narrowest part of the trunk between the anal fin and the tail fin.

snout—that part of the head in front of the eyes.

snout length—the distance from the anterior-most point of the snout to the front margin of the eye.

soft-ray—a ray that is branched, segmented, and usually flexible. Unless otherwise stated, a dorsal and anal fin ray count includes only those which are called the principal rays (the number of branched rays plus one unbranched ray, with the last ray in dorsal and anal fin counts consisting of two ray elements in which one is branched and the other is usually unbranched). The first principal dorsal or anal fin ray is usually unbranched and is followed by a branched ray. For salmonids, some workers include all the anterior rudimentary rays in a fin ray count and the term principal rays includes all rays whose length is at least 1/2 the length of the longest ray.

spine—a ray that is not branched or segmented and is usually stiff and sharp.

standard length (SL)—the straight line distance from the anterior-most point of the snout to the end of the hypural plate.

terminal mouth—a mouth with both the upper and lower jaws forming the extreme anterior tip of the head.

total length—the straight line distance from the anterior-most point of the snout to the extreme end of the caudal fin.

upper jaw length—distance from the tip of the snout to the end of the maxilla.

ventral—pertaining to on or toward the bottom or lower side.

vertebrae—the individual bones of the spinal column. In presenting vertebral counts we sometimes give the frequency of occurrence of individual counts from Alberta material.

vomer—a median bone in the roof of the mouth; may have teeth; see Fig. 7.3e.

II The Fish Families of Alberta

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8 Key to the 15 Families of Fishes of Alberta

USE THE FOLLOWING KEY and Fig. 8a to help identify a specimen's family. Begin by determining whether point 1A or 1B best describes the specimen and go to the next point indicated. Continue to select the best description of the specimen from the alternatives until a family name is given. Turn to the chapter indicated and when necessary follow the species key in the same manner to arrive at an identification. For a full explanation on how to use the keys, see Section 7.2. If you are unable to positively identify the family, see Appendix I for other families with representatives adjacent to Alberta or introduced in Alberta but not established.

1A Pectoral fin, absent only in lampreys, not reaching back to start of pelvic fin (i.e., pelvic fin always well behind pectoral fin, pelvics absent in lampreys and some sticklebacks); spines usually absent in dorsal fin (one present in catfish)..... .....GO TO 2A AND 2B.

1B Pectoral fin overlapping part of pelvic fin (i.e., part of pectoral fin lying above at least part of pelvic fin, pelvics absent in some sticklebacks); more than one spine usually present in dorsal fin (dorsal fin spines absent in burbot and livebearers; present in all sticklebacks).....GO TO 9A AND 9B.

(FROM 1A)

2A Two fins present on back (posterior one without distinct rays, may be very small, called "adipose fin" except in lamprey). .....GO TO 3A AND 3B.

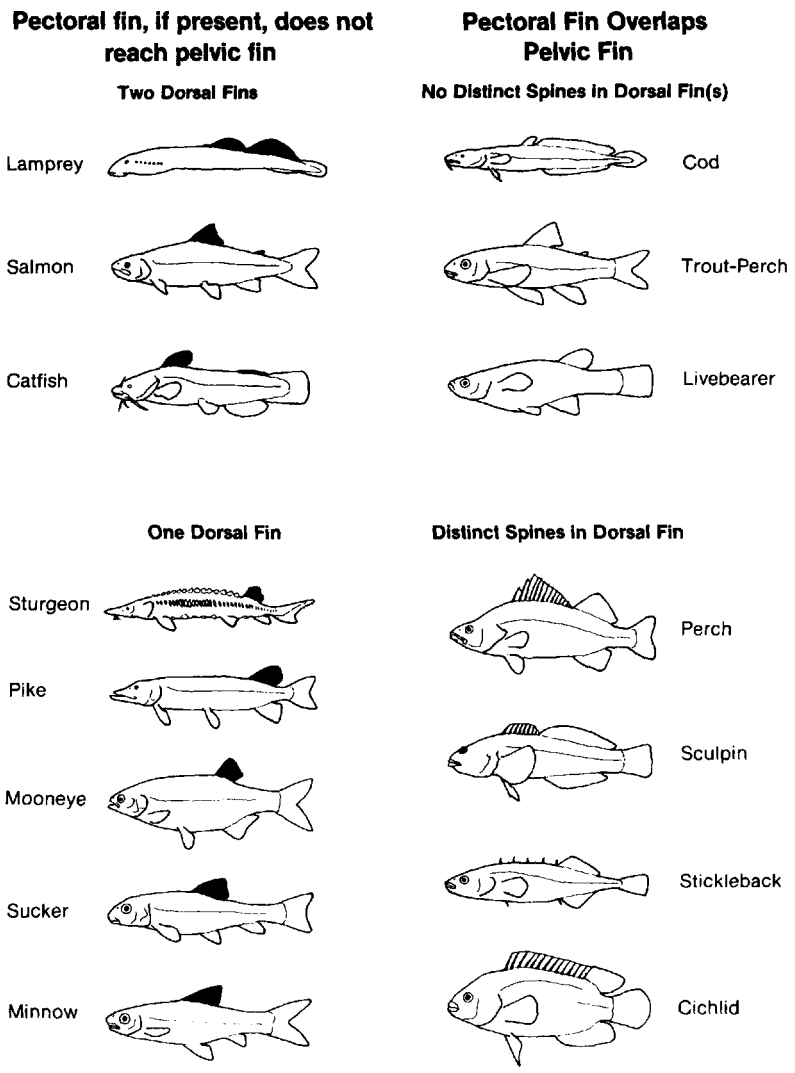


Fig. 8a Outline drawings of members of Alberta's fish families.

2B One dorsal fin present on back (called "dorsal fin").....GO TO 5A AND 5B.

(FROM 2A)

3A Sucking disc instead of jaws; seven pairs of external gill openings; body eellike; second fin on back larger than first.....**Lamprey family—Petromyzontidae.**
SEE CHAPTER 9.

3B Jaws present; one pair of external gill openings; body not eellike (except burbot); second fin on back (adipose fin) much smaller than first (the dorsal fin).....GO TO 4A AND 4B.

(FROM 3B)

4A Body with scales; barbels absent from head; pectoral fin without spinous ray [note: if adipose fin is distinctly behind the basal end of anal fin it is a trout-perch, see 11A].....**Trout family—Salmonidae.**
(Arctic grayling, cisco, whitefish, char, trout, and salmon).
SEE CHAPTER 16.

4B Body without scales; 4 pairs of barbels on front part of head; each pectoral fin with a hard spinous ray.....**Bullhead catfish family—Ictaluridae.**
SEE CHAPTER 14.

(FROM 2B)

5A Caudal fin heterocercal; entire mouth posterior to front of eye; bony shields present in 5 separated rows on body; flattened snout projecting beyond mouth by a distance exceeding width of mouth.....**Sturgeon family—Acipenseridae.**
SEE CHAPTER 10.

5B Caudal fin homocercal; front part of mouth anterior to eye; no bony shields; snout not projecting beyond mouth by a distance exceeding opening of mouth.....GO TO 6A AND 6B.

(FROM 5B)

6A Gill membranes not attached to isthmus and gill slits extended far forward ventrally; jaw teeth present; branchiostegal rays 7 or more.....GO TO 7A AND 7B.

6B Gill membranes attached to isthmus and gill slits not extended far forward; jaw teeth absent; branchiostegal rays 3 (may be obscured by flesh).....GO TO 8A AND 8B.

(FROM 6A)

7A Body elongate, standard length more than 4 times body depth; snout length about equal to length of anal-fin base; scales above lateral line more than 12; parts of head scaly; ventral surface of body rounded.....**Pike family—Esocidae.**
SEE CHAPTER 15.

7B Body compressed, standard length less than 4 times body depth; snout several times shorter than anal-fin base; scales above lateral line fewer than 9; head without scales; ventral surface of body forming a sharpish edge....**Mooneye family—Hiodontidae.**
SEE CHAPTER 11.

(FROM 6B)

8A Lips usually thick and covered with papillae or plicae (wrinkle-like folds); distance from anal-fin origin to tip of snout more than 2 1/2 times distance from anal-fin origin to base of caudal fin; pharyngeal teeth in a single row with more than 15 teeth... .....**Sucker family—Catostomidae.**
SEE CHAPTER 13.

8B Lips usually not thick, not covered with papillae or plicae; distance from anal-fin origin to tip of snout less than 2 1/2 times distance from anal-fin origin to base of caudal fin (except in some cyprinids not native to Alberta); pharyngeal teeth in 1 to 3 rows (1 or 2 rows in Alberta species) with never more than 8 teeth in any row (fewer than 6 in Alberta species)..... .....**Minnow family—Cyprinidae.**
SEE CHAPTER 12.

(FROM 1B)

9A Dorsal fin without distinct spines (weak spines may be present on leading edge of fin).....GO TO 10A AND 10B.

9B Dorsal fin with distinct spines on anterior portion (may be weak in first of two dorsal fins).....GO TO 12A AND 12B.

(FROM 9A)

10A Single long barbel on tip of lower jaw; pelvic fins inserted in front of pectoral fins; first dorsal fin very short, second dorsal fin with more than 65 rays; maximum length exceeds 16 cm ..... **Cod family—Gadidae.**
SEE CHAPTER 18.

10B No barbels on lower jaw; pelvic fins inserted behind insertion of pectoral fins; only one dorsal fin with rays and that with fewer than 15 rays; maximum length under 16 cm (most individuals less than 8 cm)..... GO TO 11A AND 11B.

(FROM 10B)

11A Adipose fin present; complete lateral line present on body; weak spines at leading edge of dorsal and anal fins..... ..... **Trout-perch family—Percopsidae.**
SEE CHAPTER 17.

11B Adipose fin absent; lateral line absent from body; no spines in dorsal or anal fins (but first three anal fin rays unbranched). ..... **Livebearer family—Poeciliidae.**
SEE CHAPTER 19.

(FROM 9B)

12A Two distinct well-developed dorsal fins..... ..... GO TO 13A AND 13B.

12B One continuous dorsal fin (isolated spines may be present). ..... GO TO 14A AND 14B.

(FROM 12A)

13A Body covered with ctenoid scales; first dorsal fin about equal in length to second dorsal fin (the first fin with more than 1/2 the number of rays as the second fin); anal fin spines one or two ..... **Perch family—Percidae.**
SEE CHAPTER 22.

13B Body without scales (small prickles may be present); first dorsal fin usually about 1/2 as long as second dorsal fin (the first dorsal

fin with about 1/2 the number of rays as the second fin); no anal fin spines.....**Sculpin family—Cottidae**.
SEE CHAPTER 21.

(FROM 12B)

14A Body without scales (bony plates may or may not be evident); dorsal fin preceded by a row of isolated spines, not interconnected with a membrane; anal fin with one spine; double nostrils on each side.....**Stickleback family—Gasterosteidae**.
SEE CHAPTER 20.

14B Body covered with ctenoid scales; dorsal fin continuous, with spines and soft rays; anal fin with three spines; single nostril on each side.....**Cichlid family—Cichlidae**.
SEE CHAPTER 23.

9 Lamprey Family—Petromyzontidae

LAMPREYS OCCUR IN fresh waters and along coastlines in cool zones of both the Northern and Southern hemispheres. All species must spawn in fresh water. The family contains about six genera with 41 species. There are 11 species known in Canada, but only one in Alberta (four in British Columbia; one, the same as in Alberta, in the Northwest Territories; and one in southeastern Saskatchewan, the chestnut lamprey, *Ichthyomyzon castaneus*).

Lampreys are either parasitic or nonparasitic. Adult parasitic lamprey feed on blood from other fish by rasping through their skin, leaving a tell-tale roundish mark of their attack. They may cause high mortality of the host fishes. All lampreys go through a larval stage; the larva is called an ammocoete. Ammocoetes burrow in the bottom sediments of streams or, less commonly, lakes, where they filter feed on minute plant and animal material. Depending on the species, the eellike ammocoete may be up to 5 to 30 cm in length at the time of metamorphosis.

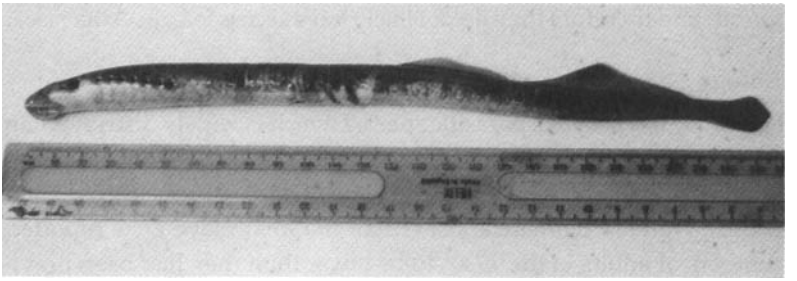
Lampreys lack all trace of bone; however, the skull is cartilagenous. They lack vertebrae, the "backbone" being a rodlike structure called a "notochord." The eellike body lacks scales and there are seven pairs of external gill openings. There are no paired fins. The caudal fin is spade-shaped.

Lampreys are our only member of the superclass Agnatha, a group of fishes with a sucking mouth disc but lacking jaws; there are numerous extinct taxa of agnathans. Lampreys are sometimes wrongly called "eels"; they are only very distantly related to true eels (anguilloids). The scientific name of the family means "stone sucker" and relates to the fact that adult members can suck onto rocks with their mouth, as

well as onto other fishes. By this action they may hold their position in moving waters while spawning or they may even ascend small waterfalls by progressively grasping upstream rocks.

9.1 Arctic Lamprey *Lampetra japonica* (Martens)

[*Lam petra:* a sucker of stone; *japonica:* from Japan]



Adult Arctic Lamprey from the Slave River, Northwest Territories. Photo courtesy of C. McLeod, RL & L Environmental Services Ltd.

Description

Color: Dark brown to gray dorsally, paler below in ammocoetes and adults (exact color can vary between young and adults).

Body: Eellike. Mouth lacking jaws; adults with circular oral sucking disc present. Median nostril. Seven pairs of lateral gill openings. No paired fins and no scales. Ammocoetes transform into adults at about 15-19 cm in length.

Size: Maximum length in North America about 40 cm.

Alberta

Although adults must at least occasionally get into Alberta, we lack specimens. The largest ammocoete of the seven larvae caught in Alberta is 15 cm long.

Distribution

● Northern Eurasia, Alaska, Yukon Territory, and western Northwest Territories including the Mackenzie River drainage from the Arctic Ocean upstream to just within the Alberta border.

■ Known in Alberta only in the larval form which has been found in the Slave River below Mountain Rapids (the most northerly rapids within the Alberta border).

Adult lampreys are known to partially ascend the lowermost rapids (Rapids of the Drowned) on the Slave River near Fort Smith, immediately

downstream (north) of the Alberta-Northwest Territories border. The above noted presence of larval lamprey upstream of the border indicates that adults at least occasionally ascend this rapids and spawn. In addition, pelicans in the Slave River near Fort Smith often take lampreys (Griffiths 1980). It is unlikely that lampreys ascend the three rapids upstream of the border, and therefore they do not likely have access to Lake Athabasca.

Biology

The Arctic lamprey is a parasitic species which is widely distributed in the Holarctic. It is normally anadromous, like Pacific salmon, but populations in Great Slave Lake and the Slave River are probably confined to fresh water. Commercial fisherman in Great Slave Lake reported numbers of adults in the 1980s to be lower than they had been previously. Much information on this species in Great Slave Lake and tributaries such as the Hay and Slave rivers may be found in Buchwald (1968).

Historical Note

E. von Martens first described the Arctic lamprey in 1868 from Japan as *Petromyzon japonicus*. It was originally noted from Great Slave Lake as *Petromyzon borealis* by Charles Girard in a report published in 1859. This report was based on a description by John Richardson of a small specimen attached to an inconnu (technically, then, it would seem that the Girard name has priority). Lamprey taxonomy is especially unsettled and because of differences of opinion on species relationships and status, our form is also known in the recent literature as *Lethenteron japonicum* or *Lampetra lamottenii* (also spelled *lamottei*). Because of uncertainty about to which species the latter name should actually be applied, Robins et al. (1980) recommended that the name *Lampetra appendix* replace *L. lamottenii* for the American brook lamprey (which some people have thought to be conspecific with our form). We present the above unusually complicated problems for this species, even though it is the most restricted native species known in Alberta and unlikely to be seen by the majority of our readers, as an example of how complex taxonomic and nomenclatorial problems can be. It is also true that we know more of these problems than we do of the biology of the species within the province!

The first and only record of lamprey in Alberta was obtained 27 and 29 August 1983 when RL & L Environmental Services Ltd. (Edmonton) caught seven larvae during a study on the Slave River for TransAlta Utilities Corp., Alberta Power Ltd., and Alberta Utilities and Telecommunications (UAMZ 6498 and 6499).

10 Sturgeon Family—Acipenseridae

STURGEONS OCCUR IN fresh waters and along coastlines in the Northern Hemisphere. All species, however, must spawn in fresh water. The family contains about 23 species, placed in four genera. Five species occur in Canada with one in Alberta (two in British Columbia; none in the Northwest Territories; and one, the same as in Alberta, in Saskatchewan).

The sturgeon family contains the largest freshwater fish in the Northern Hemisphere, some reach lengths of over 4.2 m. Sturgeon flesh is very flavorsome and the eggs are much valued for caviar. In some areas, the fish are important commercially and for sport.

All sturgeons have a ventral sucking mouth with four barbels, used for detecting food, located in a row anterior to the mouth. Five rows of hard plates termed "scutes" line the body. The upper lobe of the caudal fin is elongate (heterocercal). The skeleton is primarily cartilaginous.

The lake sturgeon is the only fish in Alberta with a spiracle; this small opening above and behind the eye is developed in most sharks and rays but is closed off in most bony fishes. The spiracular tube, extending from the pharynx to the spiracle, lies between the jaws and the hyoid arch (consisting primarily of the hyomandibular and other bones that support the branchiostegal rays). The spiracle is thought to represent a gill opening present in early fishes. Although most bony fishes lack a spiracle, they retain the pseudobranch, a gill-like structure thought to have been associated with this opening as a full gill. Although all species of *Acipenser* possess a spiracle, not all species of sturgeons possess it. For example, two species which come close to Alberta in the Missouri River drainage of Montana, the pallid and shovelnose

sturgeons of the genus *Scaphirhynchus*, lack a spiracle. In tetrapods (amphibians to mammals), the spiracular tube or cavity develops into the Eustachian tube and middle ear cavity.

The closest living relatives of the sturgeon family are the paddlefishes (Polyodontidae), confined to fresh water in China and the United States (the paddlefish is in the Missouri River drainage in Montana and was formerly known from the Milk River near Glasgow, Montana). These two families are placed in the order Acipenseriformes. This primitive order is placed in the ancient group of fishes, the infraclass Chondrostei together with the extinct Palaeonisciformes. All other Alberta fish with jaws (i.e., all but the lamprey) belong in the infraclass Neopterygii and subdivision Teleostei.

10.1 Lake Sturgeon *Acipenser fulvescens* Rafinesque

[*Acipenser:* sturgeon; *fulvescens:* in reference to its fulvous (brownish-yellow) color]

Lake sturgeon from South Saskatchewan River (Rattlesnake Hole). Photo courtesy of W.E. English.

Description

Color: Olive-gray to dark gray, whitish underneath. Peritoneum silvery with blackish viscera.

Body: Subtriangular (somewhat rounded) in section, rounded at the caudal peduncle. Head slightly rounded between the eyes, a median shallow groove down center of head; distance between the eyes 3-times (in young) to 6-times (in adults) eye diameter; eyes small; nostril openings large; snout long, flattened, and pointed in young, somewhat conical in adults; mouth ventral with front margin behind front margin of eye, lower lip with two slightly papillose lobes; teeth absent in adults, inconspicuous in very young; premaxillae fused with maxillae but mouth is protrusible; four long barbels in a transverse row in front of mouth; small opening (spiracle) between eye and upper corner of opercle. Gill membranes attached to a broad isthmus; isthmus about 1/3 width of head. Pectoral fin on lower half of body and nearly horizontal. Body with five rows of shield-like plates (pointed in young, smooth in adults). Upper lobe of caudal fin elongated (with a patch of ganoid scales on the upper lobe). Median dorsal plates in front of dorsal fin about 10-17, usually two behind; dorsolateral plates in each row about 30-40; ventro-lateral plates in each row about 7-11 in front of pelvic fin insertion, with usually two median

Map 10.1 Distribution of lake sturgeon in Alberta.

ones before and after the anal fin. About 35-40 closely set dorsal fin rays and about 25-30 closely set anal fin rays. One branchiostegal ray (on the interhyal) and 25-40 short gillrakers on a curved arch.

Size: Length up to about 2.4 m.

Alberta

Maximum length noted from Alberta is 1.7 m fork length in a specimen weighing about 33 kg taken from the South Saskatchewan River.

Distribution

- Alberta to Quebec and Nebraska to Alabama.
- Known in Alberta from the North Saskatchewan (perhaps upstream to the Brazeau River system and the lower Clearwater River, where there are specimen records), lower Red Deer, lower Bow, lower Oldman, and South Saskatchewan rivers (see Map 10.1); common in Alberta only in the South Saskatchewan River upstream to the junction of the Bow and Oldman rivers.

Biology

Lake sturgeon occur in the shallow bottom areas of lakes and large rivers. Their food consists of bottom organisms such as clams, snails, insect larvae, some fish, and plant material. Spawning probably occurs in the late spring with maturity reached when an individual is about 15 years old and about 90 cm in fork length. The lake sturgeon is the oldest at sexual maturity of all Alberta fishes; sturgeon in general are the slowest to mature of all freshwater fishes. After lake sturgeon mature they spawn approximately every 5 years. As many as 1,000,000 eggs may be produced by a large female each year that she spawns. The ripe eggs are black and are about 3 mm in diameter. Hatching occurs about one week after fertilization, and the 8 mm long young emerge with a large yolk sac. Individuals may live for longer than 60 years and with the possible exception of lake trout, are Alberta's longest-lived fish.

Several people have reported seeing sturgeon in the South Saskatchewan River leap out of the water like a missile and re-enter with a loud splash. The reason for such a behavior for a substrate feeder is unknown.

Sturgeon were probably more abundant in the North Saskatchewan River up until the early 1900s than in more recent decades. Their decrease may have been due to pollution and ecological changes in the river due to settlement and to overfishing. However, recent catches of sturgeon indicate that there has either been an increase in numbers or

that we had underestimated their abundance in recent decades. The American Fisheries Society in 1989 declared the lake sturgeon to be "threatened" (i.e., likely to become endangered in the foreseeable future). Their general biology and management in Canada is reviewed by Houston (1987).

Angling

A domestic fishery (gill net and long-line) for lake sturgeon, requiring a domestic fishing license, ceased in Alberta in 1949 because of a marked decline in the catch. A limited sports fishery requiring a special license from Alberta Fish and Wildlife has been in place since 1968. In recent years about 100-600 sturgeon have been angled per year with about 50-150 kept. Sturgeon are taken exclusively with bait using casting or spinning gear and hand lines. The bait is allowed to sink to the bottom of a pool in the river and a long wait is often in store for the angler before being rewarded with a strike. The best bait seems to be native minnows or a combination of minnows, meat, and worms. Although some sturgeon are found in the North Saskatchewan River and in the lower Red Deer River, the vast majority of the annual catch is taken from the South Saskatchewan River between the junction of the Bow and Oldman rivers and the eastern boundary of the province. Most sturgeon are angled in the Sandy Point area (near the Saskatchewan border), but the best catch per unit effort comes from Rattlesnake Hole, west of Medicine Hat (one sturgeon for every 4 hours fishing!). The fishery is closely monitored by government biologists and the annual results of the sturgeon harvest are reported (e.g., Bishop 1985).

Historical Note

C.S. Rafinesque first described the lake sturgeon in 1817 from the Great Lakes as *Acipenser fulvescens*. Whitehouse (1919) records them in Alberta from the Bow River near Bassano as *Acipenser transmontanus* (this is undoubtedly an error in identification as this Pacific drainage species gets no closer to Alberta than the Fraser River upstream from Prince George, Kootenay Lake and River, and the Columbia River above Revelstoke). There are earlier Alberta records of sturgeon, undoubtedly *A. fulvescens*, taken in the North Saskatchewan River and adjacent tributaries. For example, Moodie (1965, p.59) notes a statement in a book by G.M. Grant that sturgeon up to 10 kg ("25 pounds") were caught in the Sturgeon River as late as 1872 by men of the Sandford Fleming expedition (that river being named, no doubt, after the fish that no longer ascends this tributary).

11 Mooneye Family—Hiodontidae

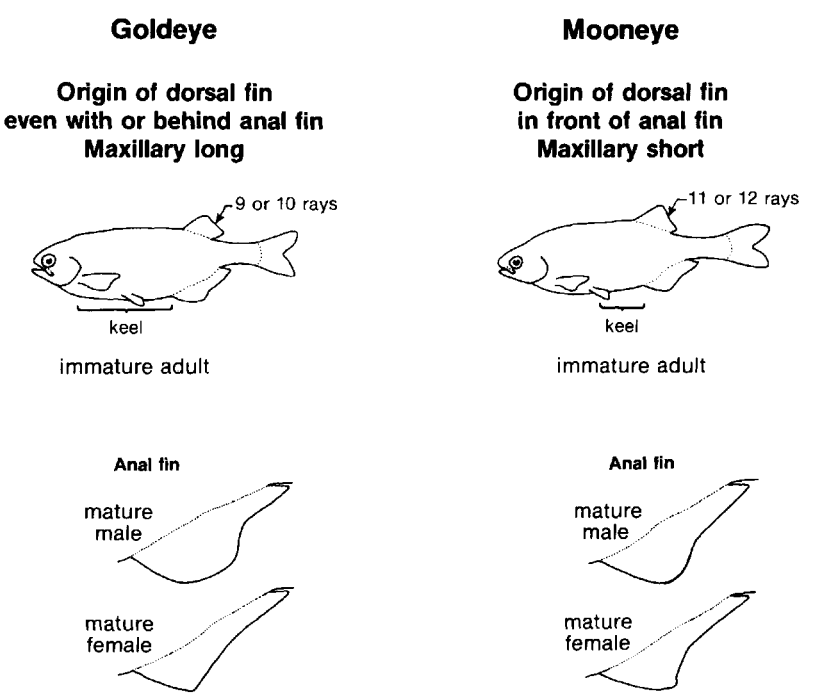
REPRESENTATIVES OF THE mooneye family are confined to the fresh waters of North America. Two species are recognized, the goldeye and the mooneye; both occur in Alberta. In addition, fossils of members of the family that lived in the Paleocene epoch have been found in Alberta.

Hiodontids, with their silvery, compressed body, are herringlike in general shape but differ most noticeably from herrings in lacking sawtooth scales on the ventral keel. They have a prominent pelvic axillary process. Teeth are present on the lower jaw, tongue, premaxillary, palatines, and parasphenoid. The 15-17 gillrakers are blunt knobs. There is only one pyloric caecum.

Hiodontids can be easily differentiated from salmonids (e.g., grayling, whitefishes, and trout) because hiodontids lack an adipose fin and most or all of the base of the dorsal fin is immediately above the base of the anal fin. Conversely, salmonids have an adipose fin and the base of their dorsal fin is fully anterior to the base of the anal fin.

The sex of mature specimens can be determined by the appearance of the anal fin. In male goldeye the outer margin of the front part of the anal fin is rounded outwardly (convex); conversely, the outer margin of the anal fin of females and immature specimens is concave or nearly straight (see Fig. 11a). Male mooneye (especially older males) have an anal fin that is similar to that of male goldeye, but the anal fin of female mooneye has a pointed tip because the first four rays are the longest (Roberts 1989). In males of both species the anterior anal fin rays are thickened near the base.

Adult goldeye and mooneye appear not to overwinter in the upper parts of their ranges in the North Saskatchewan, Red Deer, and South



Pictorial Guide to Goldeye and Mooneye of Alberta

Fig. 11a Outline drawings showing the difference between goldeye and mooneye and showing one way of telling the sex of the specimen.

Saskatchewan river drainages in Alberta. In the spring, prior to spawning, adult goldeye and mooneye appear to move upstream. After spawning, the fertilized eggs drift downstream and the young emerge in the lower reaches of the rivers. Adults migrate downstream again in the fall, perhaps overwintering still within Alberta. The young do not move upstream to their indicated range in Alberta until about age 3 or 4.

The closest living relatives to this family are the notopterids, a freshwater group occurring in tropical Africa and parts of southern Asia. The mooneyes also bear a relatively close relationship with the osteoglossids, a tropical group containing some of the largest freshwater fish in the world.

Key to the 2 Species

Use the following key to identify species in the mooneye family. For an explanation on how to use the key, see section 7.2.

1A Origin of dorsal fin even with or behind origin of anal fin; dorsal fin with 9 or 10 principal rays; mid-ventral surface keeled from near base of pectoral fins to anus; iris of eye golden but tending to be silvery in preserved specimens; maxillary long, extending past middle of eye. . **Goldeye—*Hiodon alosoides***.
SEE SECTION 11.1.

1B Origin of dorsal fin in front of origin of anal fin; dorsal fin usually with 11 or principal rays; mid-ventral surface keeled from base of pelvic fins to anus; iris of eye golden in upper half only, silvery in preserved specimens; maxillary short, not extending past middle of eye. . . . . **Mooneye—*Hiodon tergisus***.
SEE SECTION 11.2.

11.1 Goldeye
Hiodon alosoides (Rafinesque)

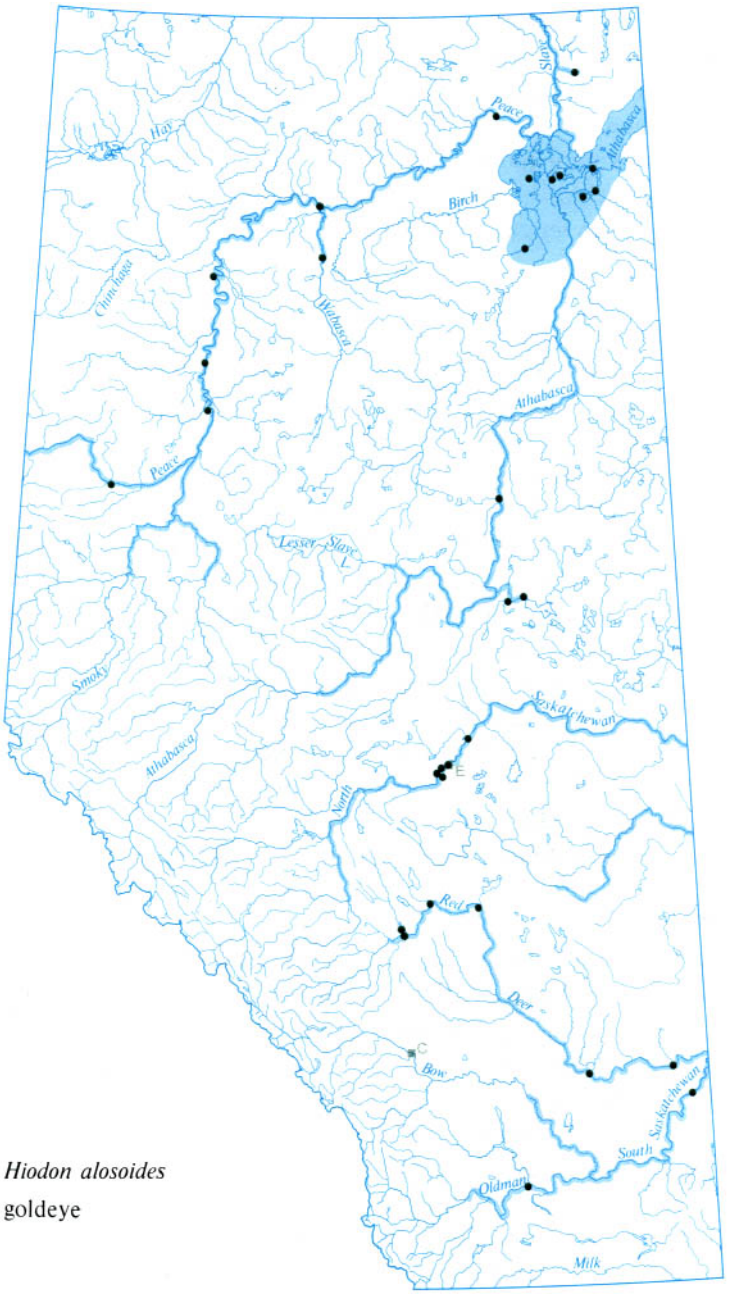
[*Hio don:* hyoid tooth; *alos oides:* shadlike]

Goldeye from Red Deer River (male upper, female lower). Note differences in shape of anal fin. These specimens carry tags for research purposes. Photo courtesy of Alberta Fish and Wildlife Division.

Description

Color: Steel bluish dorsally, silvery or white laterally. Iris of eye yellowish to golden (weakly yellowish to silvery in preserved specimens). Fins without spots; black stripe following leading edge of pectoral fin. Peritoneum silvery.

Body: Deep and highly compressed. Head blunt and strongly rounded dorsally; space between eyes about equal in length to vertical diameter of eyes; eyes large, adipose eyelids partially covering eyes anteriorly and posteriorly; mouth large (tip of maxilla extending past center of eye and maxilla much longer than eye diameter), terminal, and moderately oblique. No groove separating tip of upper jaw from snout. Teeth present on many of the bones forming the roof of the mouth (see Fig. 7.3e), tongue, and jaws. Gill membranes extending far forward, not attached to each other or to isthmus. Opercles and cheeks without scales. Origin of dorsal fin even with or behind origin



Map 11.1 Distribution of goldeye in Alberta.

of anal fin. Lateral line complete and straight. Ventral keel sharp and smooth (i.e., knife-like rather than saw-like), extending from beneath pectoral fins to anal fin. Axillary process present above the pelvic fin base. Caudal fin strongly forked. Lateral-line scales 56-65, predorsal scale rows more than 35; dorsal fin rays usually 9 or 10, anal fin rays 29-33; branchiostegal rays 7-10; gillrakers 15-19, short and knob-like.

Size: Maximum length about 51 cm.

Alberta

Unfortunately, we lack reliable length and weight records for Alberta goldeye. There is little doubt that goldeye of about 50 cm have been caught in Alberta. However, a previously reported record of 50.8 cm from the Oldman River is, on the basis of the photograph used for original verification, now known not to be a goldeye, but, on re-examination of the same photograph, a quillback (brought to our attention by W.E. Roberts). This, and other evidences of misidentification, obviously raises a serious question of reliability of past records and emphasizes the need for accurate identification. The heaviest goldeye is approximately 1.7 kg. However, on 24 June 1967, a fish identified as a goldeye was angled below the Bassano Dam on the Bow River that may have been a world record—after gills and entrails were removed it weighed 1.8 kg (McDonald 1970).

Kristensen (1981a) gives meristic counts for the Peace-Athabasca Delta region and gives the number of vertebrae as 54-58, somewhat lower than that given in other sources for this species.

Distribution

● Northeastern British Columbia, north in the Northwest Territories to near the mouth of the Mackenzie River, to Quebec and Mississippi Valley to Alabama. Absent from the Great Lakes.

■ Known in Alberta in Peace, Slave, Athabasca, North Saskatchewan, Battle, Red Deer, lower Bow, lower Oldman, and South Saskatchewan rivers and in Lake Athabasca, Claire Lake, and other shallow lakes in the Peace Athabasca-Delta area (see Map 11.1).

Kerswill (1937) notes two specimens of goldeye taken in Lesser Slave Lake in 1926. The specimens are in the Royal Ontario Museum (E.J. Crossman, personal communication). There are no subsequent records and the species was not caught during intensive investigations by Alberta's Fish and Wildlife Division in the 1970s although there was no barrier preventing their upstream movement into Lesser Slave Lake

from the Athabasca River. Bajkov's (1927) report of this species near Jasper, based on some caught in 1925, is questionable; the source of the record is not given and he notes that he did not examine specimens from the Athabasca River.

Biology

Goldeye occur in lakes and rivers, often in waters of high turbidity. They are a popular sport and commercial fish in some areas and are often taken by anglers in Alberta rivers. A study on the feeding habits of goldeye was made in the Peace-Athabasca Delta by Donald and Kooyman (1977a); these workers found their diet to consist primarily of zooplankton (e.g., cladocerans such as *Daphnia*) and aquatic and aerial insects (e.g., corixids and adult chironomids). In the Peace River, Bishop (1975a) found corixids and aquatic insect larvae to be important. The diet seems to reflect the size of the fish and availability of food items. Goldeye also feed on other fish and occasionally consume aquatic tetrapods (e.g., shrews).

Lengthy river migrations occur (Donald and Kooyman 1977b; Munson 1978). For example, Munson observed downstream movement in one individual of up to about 2000 km in 15 days. Goldeye are spring spawners, and in the Peace-Athabasca Delta spawning primarily occurs in the last half of May with the eggs hatching in early June (Donald and Kooyman 1977b). In the Delta, the sex ratio varies markedly; in some years the females comprise only about 20% of the population while in other years it is close to 50%. According to Munson (1978) and W.E. Roberts (personal communication) fully ripe females may be found in the North Saskatchewan and Red Deer rivers from about late April to late June; in these rivers some males become mature by age 3, most by age 4, and some females by age 4, most by age 5. In contrast, most females probably do not become mature in the Peace-Athabasca Delta until at least age 6. The oldest specimen noted in Alberta is thought to have been 13 years old (Kristensen 1981a).

Goldeye in the North Saskatchewan River have relatively high levels of mercury and have had levels much higher than that of other fish species in the river. Munson (1978) postulated that goldeye encountered mercury contamination in Saskatchewan. It is believed that the semi-buoyant eggs of goldeye laid in the river near Edmonton in the springtime are carried downstream across the border and that the young remain downstream until they migrate upstream at about 3 years of age (Roberts 1975a). Goldeye younger than age 3 have seldom or never been

taken near Edmonton; Paterson (1966a) interpreted this as evidence that goldeye do not spawn in the Edmonton region, a conclusion not now considered probable although evidence of drifting fertilized goldeye eggs is yet to be obtained. It was Munson's hypothesis that former chlor-alkali plants that operated in Saskatoon contaminated Tobin Reservoir where goldeye may reside before moving upstream. Although this may have been the dominant source of mercury for these goldeye, local sources of mercury may also have been taken up by the goldeye. There is a widespread occurrence of low concentrations of mercury in many fishes in Alberta and one source may well be naturally occurring deposits of this element. Fortunately, the chlor-alkali plants closed in 1978 and mercury concentrations in goldeye in the North Saskatchewan River have dropped since Munson's study.

Angling

Goldeye probably have not achieved the reputation of a fine game fish in Alberta that they rightly deserve. When taken on light tackle, this fish can provide sport comparable to some species of trout of equivalent size. They will take both wet and dry flies, but most of the goldeye taken by anglers are caught on baits or small spinning lures. Favored places for goldeye fishing are in large turbid rivers near the mouths of small tributary streams or where a backwater meets an area of moderate current. The Peace, Athabasca, Pembina, North Saskatchewan, Red Deer, and South Saskatchewan rivers all have potentially good sport fisheries for goldeye. This species may be caught from April throughout the open water season, with late May to August being most productive.

Historical Note

C.S. Rafinesque first described the goldeye in 1819 from the Ohio River as *Amphiodon alveoides* (= *alosoides*). Eigenmann (1895) reported goldeye being present at Medicine Hat. Preble (1908) reported it to be common in the Athabasca and Slave rivers. Whitehouse (1919) noted goldeye from the Red Deer River and referred to a report of it in the Peace River. It was found in the Athabasca area in 1920 (Kendall 1924, erroneously listed in the cyprinid section). Williams (1946) notes the presence of goldeye near the mouth of the St. Mary River on 1 July 1923. However, historical reports of goldeye in South Saskatchewan River drainage may (also) represent mooneye.

11.2 Mooneye
Hiodon tergisus Lesueur

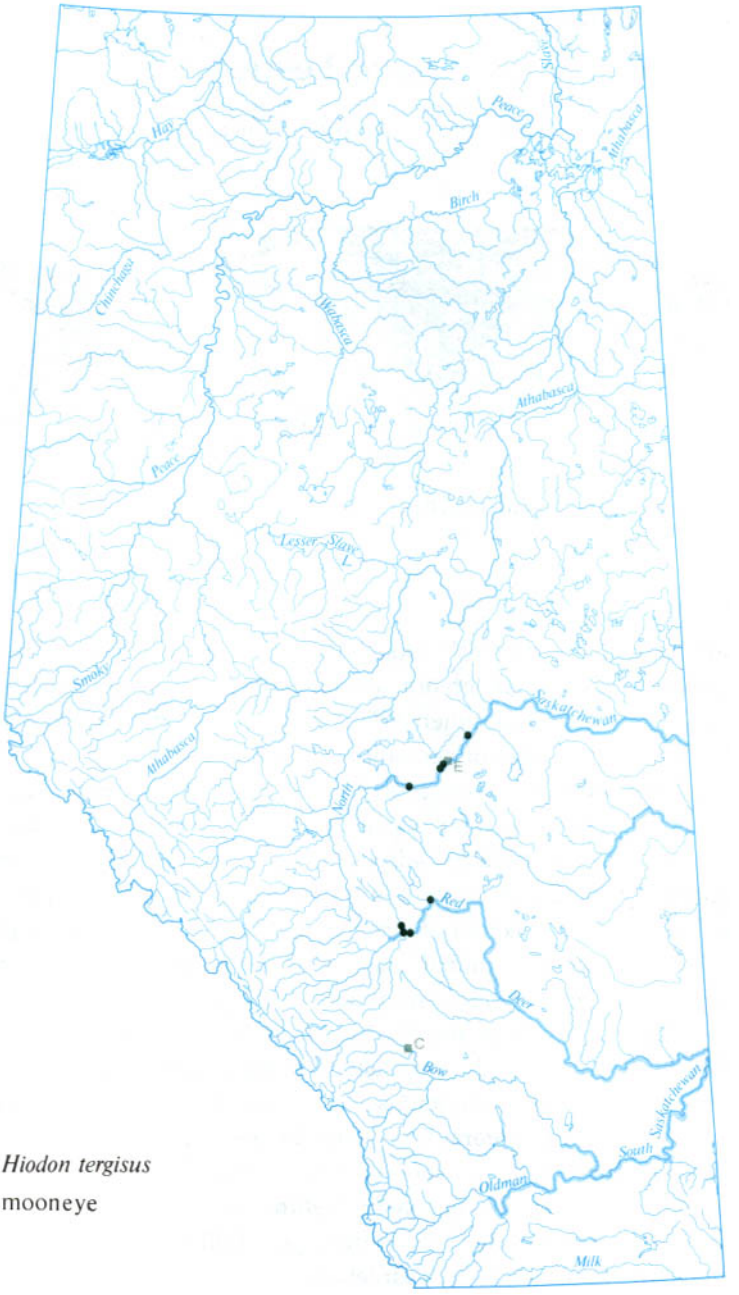
[*Hio don:* hyoid tooth; *tergisus:* polished (in appearance)]

Mooneye, 26 cm fork length, from Red Deer River. Photo courtesy of W.E. Roberts.

Description

Color: Brownish to greenish dorsally, silvery or white laterally. Iris of eye often slightly golden dorsally and silvery below (all of iris silvery in preserved specimens). Fins without spots; black stripe following leading edge of pectoral fin. Peritoneum silvery.

Body: Deep and highly compressed. Head blunt and strongly rounded dorsally; space between eyes about equal in length to vertical diameter of eyes; eyes large, adipose eyelids partially covering eyes anteriorly and posteriorly; mouth moderately large (tip of maxilla only extending to center of eye and maxilla about equal in length to eye diameter), terminal, and moderately oblique. No groove separating tip of upper jaw from snout. Teeth present on many bones forming the roof of the mouth, tongue, and jaws. Gill membranes extending far forward, not attached to each other or to isthmus. Opercles and cheeks without scales. Origin of dorsal fin in front of origin of anal fin. Lateral line complete and straight. Ventral keel sharp and smooth (i.e., knife-like rather than saw-like), extending from base of pelvic fins to anal fin (ventral profile between pectoral and pelvic fins rounded, unlike goldeye). Axillary process present above the pelvic fin base. Caudal fin strongly forked. Lateral-line scales 54-60, predorsal scale rows fewer than 35; dorsal fin rays usually 11 or 12, anal fin rays 27-31; branchiostegal rays usually 8; gill-rakers 16-21, short and knob-like.



Map 11.2 Distribution of mooneye in Alberta.

Size: Maximum length about 47 cm.

Alberta

Maximum length for Alberta is 31.25 cm fork length in a specimen from the Red Deer River east of Innisfail (UAMZ 6955), and maximum weight is 0.499 kg in a specimen from the Red Deer River west of Innisfail (UAMZ 7618); both fish angled by W.E. Roberts.

Distribution

● Central Alberta through Saskatchewan and Manitoba, absent from most of Ontario but extending northward to southern James Bay drainages and south to the lower Mississippi drainage.

■ Known in Alberta in North Saskatchewan, Battle, Red Deer, lower Bow, lower Oldman, and South Saskatchewan rivers and lower reaches of their major tributaries (see Map 11.2).

Biology

Mooneye are not as widely distributed as goldeye in Alberta and have only been distinguished from that species by provincial biologists since about 1973. However, mooneye can be very abundant locally and can even exceed goldeye in numbers. Mooneye and goldeye are the most common sportfish in many areas. Information on the biology of mooneye in Alberta is given by Roberts (1989).

As with goldeye, spawning occurs in the springtime (probably from late April to June). Mooneye feed on invertebrates and are known to live up to 11 years. The absence of mooneye from rivers such as the Athabasca and Slave where goldeye are present may be due to their not being at the right place (i.e., in Glacial Lake Edmonton) at the right time to have dispersed from the Saskatchewan drainage to the Athabasca drainage rather than to any inability to live in those waters.

Angling

Because of previous confusion with the somewhat larger goldeye (in Alberta), mooneye have only recently become recognized as one of our game species. Angling methods are very similar to those used for goldeye. Mooneye are occasionally taken by anglers in pursuit of goldeye.

Historical Note

C.A. Lesueur first described the mooneye in 1818 from Lake Erie as *Hiodon tergisus*. Roberts (1974) was the first to record the mooneye from

Alberta from specimens taken in 1973 from the Red Deer River (at the confluences of the Medicine and Blindman rivers) and the North Saskatchewan River at Edmonton. Specimens were taken earlier from the North and South Saskatchewan rivers but not recognized as mooneye at the time, the earliest collection being by L. Gudmundson in 1968 from the lower Sturgeon River.

We assume mooneye were rare in Alberta prior to 1973, although some may have been erroneously identified as goldeye. There appears to have been a marked increase in their numbers since 1973, possibly due to the filling of reservoirs in Saskatchewan that now may provide overwintering habitat.

Mooneye and goldeye are very similar species to the untrained eye and general reports of or reference to either mooneye or goldeye cannot be accepted without knowing the criteria used in the identification. To further confuse matters, the term mooneye can be used as a collective term for the family (i.e., the mooneye family; mooneyes) as well as for a particular species (i.e., the mooneye).

12 Minnow Family—Cyprinidae

MEMBERS OF THE MINNOW family are found in North America, Africa, Europe, and Asia. Their greatest diversity is in southeast Asia. This freshwater family contains about 2,000 species and is probably the largest of not only all fish families in the world but of all vertebrate families (only the goby family, a group found mainly in warm marine waters, has about as many species). Some 48 species of minnows (and four introduced ones) occur in Canada (McAllister 1990), with 14 species native to Alberta (about 15 in British Columbia, 10 of which are the same as in Alberta; 9 in the Northwest Territories; and 18 in Saskatchewan). Many tropical minnows give pleasure in home aquaria.

Of the 14 species of minnows in Alberta the longnose dace and lake chub are the most widespread, occurring in both lakes and streams throughout the province. East of the Rocky Mountains and foothills, the fathead minnow and spottail shiner are also widespread and abundant; the former being the minnow most likely to be found in small shallow lakes and small creeks devoid of game fish (although other minnows can occur in such situations and fathead minnows do occur along the shoreline of large deep lakes). Within Alberta, two of our minnows are limited to the Arctic drainage (northern squawfish and redside shiner) and two are excluded from the Arctic drainage area (western silvery minnow and river shiner).

Most minnows are small fish, seldom exceeding 15 cm in length. They spawn in the spring and summer. Many people erroneously refer to any small fish as a minnow, but all fish species have small individuals and the term minnow properly refers only to members of one particular family. Although minnows do make up the bulk of our small fishes, not all minnows are small; for example, the northern squawfish

grows to over 60 cm in length. Minnows feed primarily on algae and zooplankton and in turn serve as prey for many game fish and other animals such as cormorants, terns, and mink; however, some minnows (e.g., northern squawfish) may themselves feed on other fish. Other minnows (e.g., common carp) may cause effects to the environment that are detrimental to native fish. Although little used in sport except as baitfish, some minnows, such as the lake chub and flathead chub, do add to the diversity available to the angler. Minnows are frequently and easily observed and deserve the same respect as any other species.

Minnows, like suckers, lack teeth in their mouth. Instead, in both families, there is a series of teeth on the pharyngeal arch (ceratobranchial of the fifth gill arch). Counts of these teeth are not required to name any Alberta minnow, but it is desirable in many cases to use this character in verifying identifications. This character can also be useful in identifying minnows in stomach contents of various animals. The pharyngeal arch lies adjacent to the shoulder girdle and may be easily removed through the opercular opening (great care is necessary to avoid breaking any teeth) (Fig. 12a). The arch is best removed by running a sharpened probe back and forth between the inside margin of the shoulder girdle (cleithrum) and the outside margin of the pharyngeal arch. When muscles at the ends of the arch are broken it can be removed by gently lifting it out. The teeth of native North American minnows may be in one or two rows on each side. In some Old World minnows and aberrant specimens of some North American species there are three rows but, unlike suckers, there are never more than eight teeth (fewer than six in Alberta species) in any one row in any minnow. The teeth in each row are counted and given in a formula from left to right. A dash separates counts on the two sides. Thus, a count of 2,5-4,2 indicates that there are two teeth on the outer row, five teeth on the inner row of the left arch and four teeth on the inner row, two teeth on the outer row of the right arch. The pharyngeal arch must be examined under magnification to ascertain the presence of broken teeth or an old socket where a tooth once was. Preferably, counts on several specimens should be made.

Minnows have three branchiostegal rays (one epihyal and two ceratohyal) and 30-46 vertebrae. In most species the upper jaw margin is formed by only the premaxillae. The caudal fin has 17 branched rays.

Minnows are placed in the order Cypriniformes, along with suckers (and the Old World loaches and algae eaters). Members of this order and of the characiforms (tetras etc.) and siluriforms (catfishes) belong

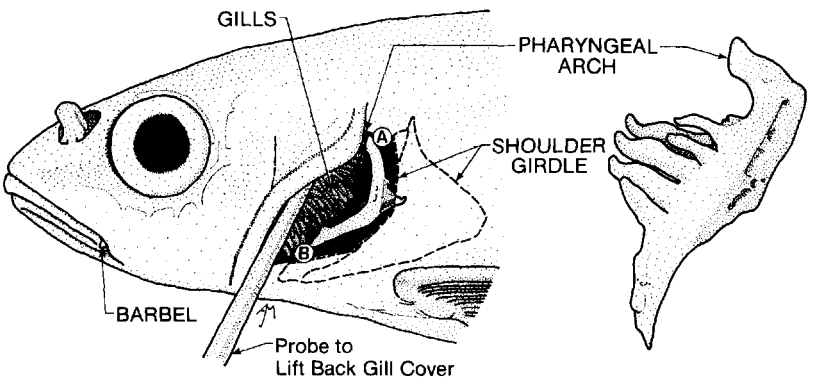


Fig. 12a Head and pharyngeal arch of lake chub, *Couesius plumbeus*, from Alberta. In the left diagram the gill cover has been lifted back with a probe to expose the pharyngeal arch lying against the shoulder girdle (the arch and girdle are covered with skin and are not readily distinguished as shown here). The arch is removed by running a sharpened probe back and forth between points A and B (see text). The arch shown on the right has been rotated to show the two outer and four inner teeth. Note also the presence of the barbel at the end of the mouth.

to the series Otophysi which are characterized by having a series of four modified vertebrae which connect the swim bladder to the inner ear. The four modified vertebrae and their processes, called the "Weberian apparatus," permits these fish to "hear" by amplifying and transmitting vibrations in the water from the swim bladder to the inner ear. There are several modified processes of the Weberian apparatus called "Weberian ossicles" that allow the vibrations to be transmitted. The claustrum and scaphium are basically dorsal to the first vertebrae, the intercalarium is lateral to the second vertebra, and the fourth and largest ossicle, the tripus, projects beneath the third vertebra. The fourth vertebra is also modified and has connections with the tripus.

The Otophysi, along with such fish as the milkfish and gonorynchids, form the large superorder Ostariophysi. Most members of this group exhibit a fright reaction caused by an alarm substance, termed *Scheckstoff* and discovered by the Austrian ethologist Karl von Frisch, which is released when certain skin cells of the fish are ruptured (such as by a predator). This seems to be an adaptation which helps allow individuals in a school of one species to escape from danger.

Winfield and Nelson (1991) give a comprehensive review of the family.

Key to the 14 Species

Use the following key and Fig. 12b to identify species in the minnow family. For an explanation of how to use the key, see section 7.2. See Appendix I for information on several other species, either sometimes released into Alberta waters, found in adjacent regions, or formerly thought to occur in Alberta.

1A Barbel distinct and clearly visible at or near posterior end of upper jaw.....GO TO 2A AND 2B.

1B Barbel absent (small and hidden in pearl dace, *Margariscus margarita*).....GO TO 4A AND 4B.

(FROM 1A)

2A Groove between premaxillaries and snout not continuous across midline (frenum present); tip of upper jaw extending well past lower jaw (with snout projecting far beyond mouth).....**Longnose dace—*Rhinichthys cataractae*.**
SEE SECTION 12.13.

2B Groove between premaxillaries and snout continuous across midline (frenum absent); tip of upper jaw extending slightly, if at all, past lower jaw except for *Platygobio* where the upper jaw extends forward well past the lower jaw.....GO TO 3A AND 3B.

(FROM 2B)

3A Area between eyes flattened, distance between eyes 2 times eye diameter or greater; mouth extending to below front of eye; tip of upper jaw extending distinctly forward past lower jaw; origin of dorsal fin opposite (vertically above) or slightly in front of insertion of pelvic fins; barbel placed at end of upper jaw, length usually longer than 1/2 diameter of eye pupil; scales above lateral line fewer than 10; tip of pectoral fins pointed.....**Flathead chub—*Platygobio gracilis*.**
SEE SECTION 12.11.

3B Area between eyes rounded, distance between eyes less than 2 times eye diameter; mouth not quite extending to below front

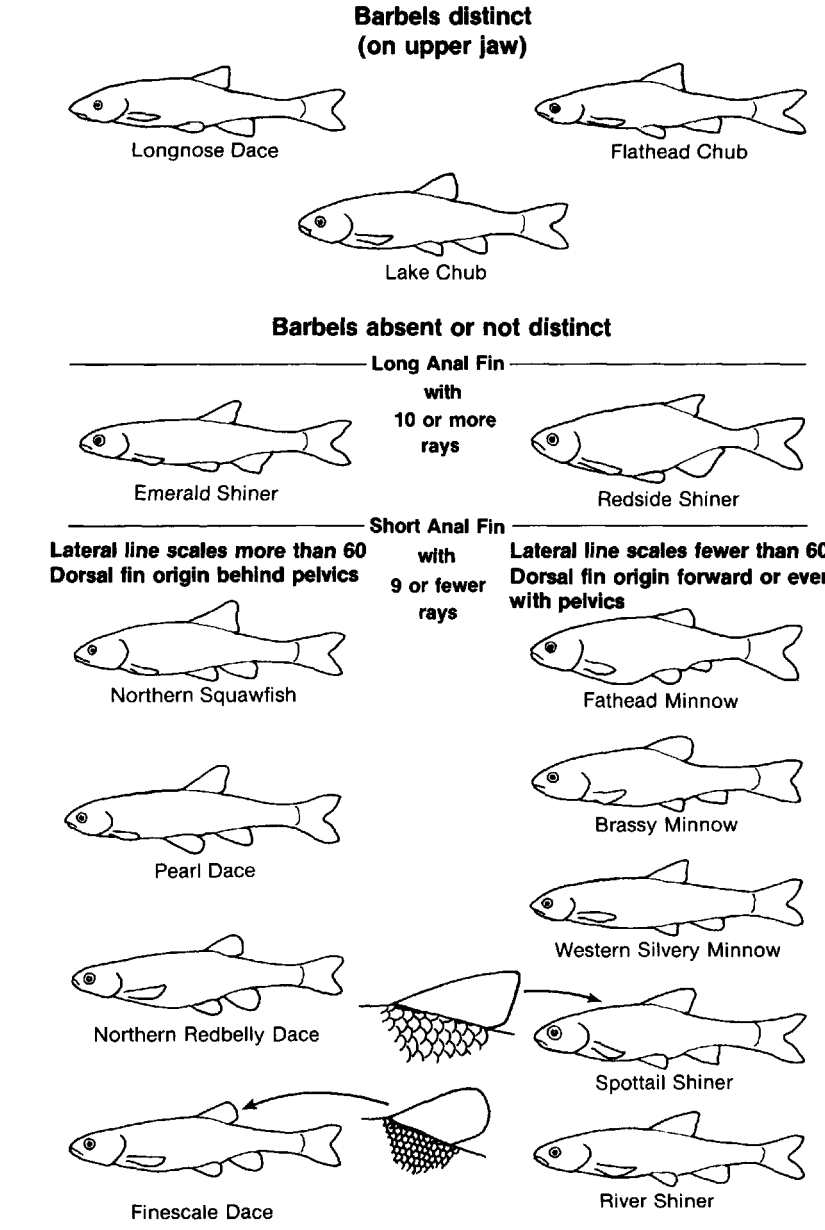


Fig. 12b Outline drawings to supplement the Key to the 14 native cyprinids of Alberta.

of eye; tip of upper jaw at most extending only slightly farther forward than lower jaw; origin of dorsal fin slightly behind insertion of pelvic fins; barbel placed very slightly ahead of end of upper jaw, length usually shorter than 1/2 diameter of eye pupil; scales above lateral line more than 9; tip of pectoral fins rounded ..... **Lake chub—*Couesius plumbeus*.**
SEE SECTION 12.1.

(FROM 1B)

4A Anal fin with 10 or more rays; origin of dorsal fin distinctly behind insertion of pelvic fins..... GO TO 5A AND 5B.

4B Anal fin with 9 or fewer rays; dorsal fin position variable... ..... GO TO 6A AND 6B.

(FROM 4A)

5A Anal fin rays 10-12; scales above lateral line fewer than 9; color on side primarily with silver and black tones only..... ..... **Emerald shiner—*Notropis atherinoides*.**
SEE SECTION 12.5.

5B Anal fin rays usually 13-17 (extremes 10-22); scales above lateral line more than 10; breeding males with yellow and crimson on side, some color on all adults..... ..... **Redside shiner—*Richardsonius balteatus*.**
SEE SECTION 12.14.

(FROM 4B)

6A Scales along lateral line more than 60; scales above lateral line 11 or more; origin of dorsal fin behind insertion of pelvic fins ..... GO TO 7A AND 7B.

6B Scales along lateral line fewer than 55; scales above lateral line 11 or fewer; origin of dorsal fin even with or in front of insertion of pelvic fins..... GO TO 10A AND 10B.

(FROM 6A)

7A Lateral line complete (except in young); scales along lateral line fewer than 76 (scales small but visible); peritoneum silvery. ..... GO TO 8A AND 8B.

7B Lateral line incomplete, pores not extending past dorsal fin; scales along normal position of lateral line usually more than 75 (scales exceedingly small); peritoneum black or brownish-black.....GO TO 9A AND 9B.

(FROM 7A)

8A Mouth large, generally extending past front of eye; scales above lateral more than 14; depth of caudal peduncle less than length of dorsal fin base; barbel on upper jaw never present; young with black spot at base of caudal fin.....**Northern squawfish—*Ptychocheilus oregonensis*.**
SEE SECTION 12.12.

8B Mouth of moderate size, not extending past front of eye; scales above lateral line fewer than 14; depth of caudal peduncle about equal to length of dorsal fin base; small barbel present ahead of end of upper jaw (not visible when mouth closed and sometimes absentoften requires microscopic examination); young with blackish lateral band extending from gill cover to base of tail.....**Pearl dace—*Margariscus margarita*.**
SEE SECTION 12.4.

(FROM 7B)

9A Mouth very oblique, not extending to front of eye; two distinct black lateral bands in adult; intestine long, usually with several loops or coils; pharyngeal teeth in one row, usually 0,5-5,0.....**Northern redbelly dace—*Phoxinus eos*.**
SEE SECTION 12.8.

9B Mouth moderately oblique, usually extending to front of eye; only one distinct lateral band; intestine short, usually with a single coil; pharyngeal teeth in two rows, usually, 2,5-4,2.....**Finescale dace—*Phoxinus neogaeus*.**
SEE SECTION 12.9.

(FROM 6B)

10A Tip of upper jaw not extending forward past lower jaw (mouth terminal or nearly so); scales before dorsal fin crowded, in 21 or more rows and much smaller than those on rest of body; scales above lateral line 9 or more; dorsal fin in mature male with a

stout, blunt-tipped, anterior half-ray that is distinctly separated from the first principal ray; lateral line incomplete; head of breeding males nearly black and with numerous prominent nuptial tubercles..... **Fathead minnow—*Pimephales promelas*.**
SEE SECTION 12.10.

10B Tip of upper jaw extending forward slightly past lower jaw (mouth subterminal); scales before dorsal fin not unusually crowded or smaller than those on rest of body, in 19 or fewer rows; scales above lateral line 7 or fewer; dorsal fin with the anterior half-ray slender and tightly bound to the first principal ray; lateral line complete; head of breeding males not black and tubercles, if any, not prominent to the naked eye.....
.....GO TO 11A AND 11B.

(FROM 10B)

11A Scales around caudal peduncle 13 or more; gillrakers on first arch 9 or more; peritoneum blackish or black; intestine elongate, about twice standard length or more; pharyngeal teeth 0,4-4,0
.....GO TO 12A AND 12B.

11B Scales around caudal peduncle usually 12 or fewer; gillrakers in first arch 9 or fewer; peritoneum silvery; intestine much less than twice standard length; pharyngeal teeth usually 1 or 2,4-4,2 or 1.....GO TO 13A AND 13B.

(FROM 11A)

12A Dorsal fin rounded at tip; sides yellowish or brassy in life, dusky lateral band often present; dorsal fin rays outlined with melanophores (black pigment cells); usually 15-20 small radii in scales of adults (grooves radiating toward center of scale).....
..... **Brassy minnow—*Hybognathus hankinsoni*.**
SEE SECTION 12.3.

12B Dorsal fin somewhat pointed at tip; sides silvery in life, no dusky lateral band; dorsal fin rays not outlined with melanophores; about 10 distinct radii in scales of adult.....
..... **Western silvery minnow—*Hybognathus argyritis*.**
SEE SECTION 12.2.

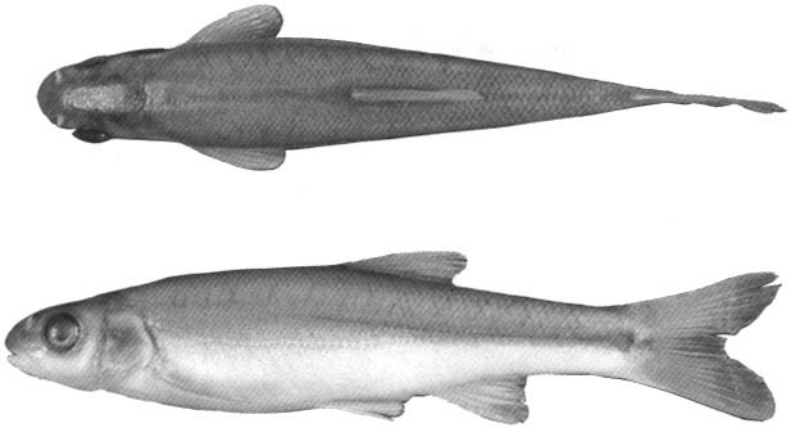
(FROM 11B)

13A A large conspicuous black spot (very rarely faint) at the base of the caudal fin; anal fin usually with 8 rays; upper jaw length usually shorter than diameter of eye..... .....**Spottail shiner—*Notropis hudsonius*.**
SEE SECTION 12.7

13B No large conspicuous black spot on the base of the caudal fin; anal fin usually with 7 rays; upper jaw usually longer than diameter of eye.....**River shiner—*Notropis blennius*.**
SEE SECTION 12.6.

12.1 Lake Chub *Couesius plumbeus* (Agassiz)

[*Couesius:* after Dr. Elliot Coues, an ornithologist; *plumbeus:* lead colored]

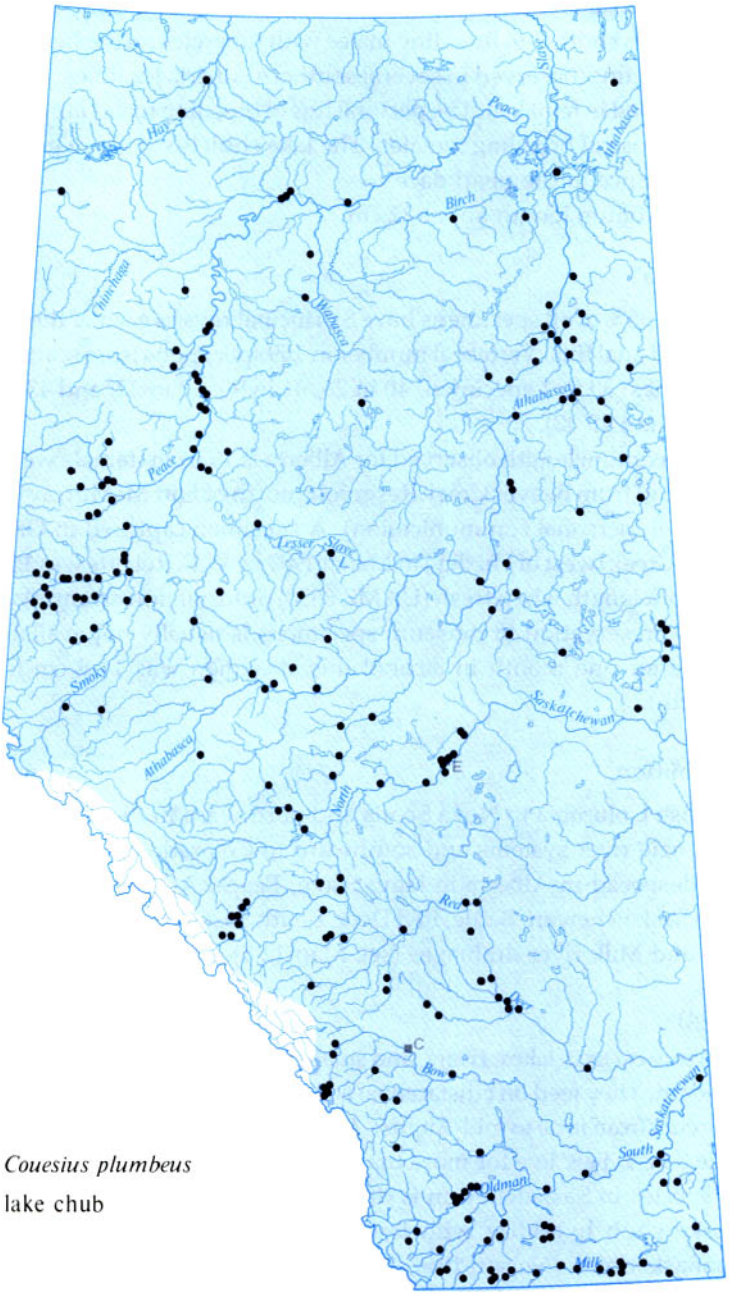


Lake chub adults, about 54 mm standard length, from Little Smoky River.

Description

Color: Darkish or greenish dorsally, silvery laterally. Young with a distinct black lateral band from gill cover to tail and usually extended around snout and across upper lip, band often present in adults on posterior part of body. Peritoneum silvery with only a few black spots or light dusky appearance. Mature males have a distinct orange to reddish patch behind the pectoral fin base and occasionally elsewhere.

Body: Rounded in section. Head conical and slightly rounded dorsally, space between eyes about 1 3/4 times eye diameter; eyes large; mouth large (extending to front margin of eye and about equal in length to eye diameter), terminal, and slightly oblique; barbels moderately conspicuous and placed very slightly ahead of end of upper jaw. Isthmus narrow, about 1/4 width of head. Origin of dorsal fin over or behind insertion of pelvic fins. Lateral line complete and decurved. Caudal fin moderately forked. Lateral-line scales 54



Map 12.1 Distribution of lake chub in Alberta.

to 70; dorsal and anal fin rays 8; pharyngeal teeth usually 2,4-4,2; gillrakers short, 3-9. Breeding males with tubercles on the head and pectoral fins (observed in several southern Alberta localities; poorly developed in females). The pectoral fins of breeding males are longer than those of breeding females. The lake chub is similar in general appearance to the pearl dace.

Size: Maximum length about 22 cm.

Alberta

About 98% of all specimens have 8 principal rays in each of the dorsal and anal fins. Vertebral number in 159 specimens from scattered localities: 39 in 1 specimen, 40 in 26, 41 in 96, 42 in 32, and 43 in 4 (97% had 40-42).

Maximum length observed for Alberta is 16.6 cm (female weighing 61 g) from Beaver Creek Reservoir, north of Fort McMurray (Jim O'Neil, personal communication). A specimen captured in Ghost Pine Creek (west of Huxley) in March 1989 by W.E. Roberts was 15.25 cm fork length when fresh (UAMZ 6830) (information on shrinkage with preservation in museum specimens is usually not available, but after one month in alcohol this specimen was 14.8 cm fork length).

Distribution

● British Columbia to Nova Scotia and northward in the Yukon and Mackenzie river systems and southward to Colorado.

■ Widespread in Alberta in Hay, Slave, Peace, Athabasca, Beaver, North Saskatchewan, Battle, Red Deer, South Saskatchewan, Oldman, Bow, and Milk river drainages (see Map 12.1).

Biology

Lake chub occur in lakes, rivers, and small creeks and are often extremely abundant. They feed on crustaceans, aquatic insects, and algae. Spawning occurs from June to mid-August. Maturity is probably reached when at age 3 or 4. Few live for more than 5 years. The breeding biology of this species in Saskatchewan is described by Brown et al. (1970).

Lake chub hybridize with longnose dace in Upper and Lower Kananaskis lakes (Nelson 1966, 1973a; Butcher 1979, 1980) and possibly hybridize with pearl dace in the Sass River just north of the Alberta border (Wells 1981).

Historical Note

L. Agassiz first described the lake chub in 1850 from Lake Superior as *Gobio plumbeus*. It was formally placed in the genus *Hybopsis* (as *Hybopsis plumbea*) by some workers; many similarities exist with *Semotilus*, *Margariscus*, and *Rhinichthys*. The lake chub was first noted in Alberta by Eigenmann (1895) at Medicine Hat and Calgary as *Couesius dissimilis*.

Three forms of lake chub have been recognized: the western "greeni" (centered in the Columbia-Fraser river drainage), the central "dissimilis" (centered in the Missouri River drainage), and the eastern "plumbeus" (centered in the Mississippi River and Great Lakes drainage). The geographic variation of the species and an analysis of intergradation of the three forms is described by Wells (1978). The Liard River Hotspring population in northern British Columbia was found to be distinct.

12.2 Western Silvery Minnow *Hybognathus argyritis* Girard

[*Hybo gnathus:* protuberant jaw; *argyritis:* silvery]

Western silvery minnow, 89 mm standard length, from Milk River drainage, east of the town of Milk River.

Description

Color: Brownish-yellow dorsally, silvery laterally. Lateral band absent (dusky spots may be present). Dorsal, pectoral, and pelvic fin rays not outlined with melanophores. Peritoneum dusky black, some silver showing through.

Body: Moderately compressed. Head conical and moderately rounded dorsally, distance between eyes about 2 times eye diameter; eyes moderate; mouth small (not extending to front margin of eye and about equal in length to diameter of eye), subterminal, and slightly oblique; barbels absent. Isthmus very narrow, less than 1/4 width of head. Origin of dorsal fin in front of (sometimes only slightly so) insertion of pelvics. Anterior tip of dorsal and pectoral fins pointed. Lateral line complete and decurved. Scales with about 10 distinct radii on posterior margin in adults. Intestine very long, with numerous coils. Caudal fin moderately forked. Lateral-line scales 36-40; dorsal fin rays 8 and anal fin rays usually 8; pharyngeal teeth 0,4-4,0.

Size: Maximum length 15 cm.

Alberta

Meristic counts in 15 specimens obtained from the Milk River drainage are as follows. Scales along lateral line 36-39; above lateral line 5 or 6; and around caudal peduncle 13 or 14 (most at 14).

Map 12.2 Distribution of western silvery minnow in Alberta.

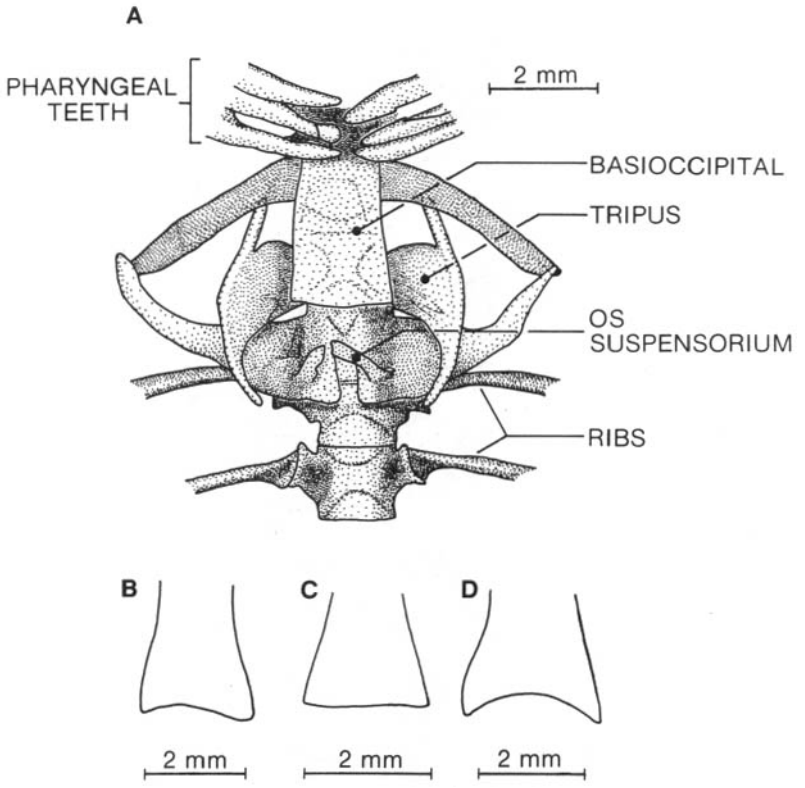


Fig. 12.2a Basioccipital process of *Hybognathus argyritis* from the Milk River: ventral view of first few vertebrae showing some of the Weberian ossicles. The basioccipital process (labelled "basioccipital") is an extension of the basioccipital bone. A (8.8 cm standard length), B (9.5 cm standard length), and C (7.6 cm standard length) from the Milk River south of Orion (cleared and stained specimens-UAMZ 3339) and D (9.0 cm standard length) from the Milk River west of Deer Creek (dissected-UAMZ 3548). Drawings scaled to standard length. The shape of the basioccipital process has been used to separate some species of *Hybognathus*. *H. argyritis* is said to have a basioccipital process that is longer than wide with a shallowly concave or truncate posterior margin while *H. nuchalis* is said to have one whose greatest width is about equal to and its length and with a deeply concave posterior border. A wide range of variation exists in our specimens of what is thought to be *H. argyritis*. Cleared and stained specimens from the Milk River west of Wildhorse (UAMZ 3234) show similar variation. A detailed study of the variation of this character and its significance to *Hybognathus* taxonomy is needed.

Gillrakers on first gill arch: upper arch 2 or 3; lower arch 7 or 8; total 9-11. The gillrakers are longer and more distinct than on most other Alberta minnows. Vertebral number in 17 specimens from the Milk River within Alberta 39-41, with the majority at 40. There is considerable variation in Alberta in the shape of the basioccipital process (Fig. 12.2a).

Maximum length noted in Alberta is 10 cm fork length from the Milk River near Milk River townsite.

Distribution

● Southern Alberta to southern Manitoba and southward through Missouri drainage to region near confluence of the Missouri and Ohio rivers.

■ Known in Alberta in the Milk River (see Map 12.2); Henderson and Peter (1969) report it from the South Saskatchewan on the basis of one specimen (we would like to obtain additional records from this river before recognizing it as established there).

Biology

We know very little about the biology of western silvery minnows. They feed primarily on algae.

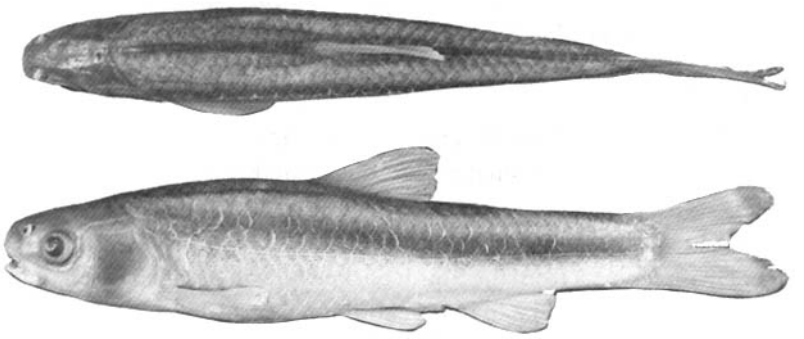
Historical Note

C.F. Girard first described the western silvery minnow in 1856 from Milk River in Montana as *Hybognathus argyritis*. It was first collected in Alberta by Grant Campbell on 13 May, 1961 from the eastern portion of the Milk River. Additional specimens were collected by Henderson and Peter (1969) in 1963 from the South Saskatchewan River at Medicine Hat (one specimen) and by Willock (1968) in 1966 from the Milk River east of Milk River townsite.

This species was formerly referred to in Alberta as *H. nuchalis* Agassiz, a species complex now known to consist of three species. Our form is the resurrected *H. argyritis*; *H. nuchalis* is the form that occurs in the Mississippi River Basin and adjacent areas.

12.3 Brassy Minnow *Hybognathus hankinsoni* Hubbs

[*Hybo gnathus:* protuberant jaw; *hankinsoni:* after Dr. T.L. Hankinson, an ichthyologist]



Brassy minnow adults, 57 mm standard length, from Halfbreed Creek, Milk River drainage near Aden.

Description

Color: Olive-green dorsally, brassy-yellow to dull silvery laterally. Darkish lateral band extending from gill cover to tail, often indistinct anteriorly. Dorsal, pectoral, and pelvic fin rays outlined with melanophores. Peritoneum jet black to dusky black.

Body: Moderately compressed. Head conical and moderately rounded dorsally, distance between eyes about 2 to 2 1/2 times eye diameter; eyes moderate; mouth small (not extending to front margin of eye and about equal in length to eye diameter), subterminal (snout distinctly projected beyond lower jaw), and slightly oblique; barbels absent. Isthmus very narrow, less than 1/4 width of head. Origin of dorsal fin in front of insertion of pelvic fins. Anterior tip of dorsal and pectoral fins rounded. Lateral line complete and slightly decurved. Scales usually with 15-20 radii on posterior margin (may be difficult to locate) in adults. Intestine long, with numerous coils. Caudal fin moderately forked. Lateral-line scales 35-40; dorsal fin rays 8 and anal fin rays usually 8; pharyngeal teeth 0,4-4,0.

Size: Maximum length 10 cm.

Map 12.3 Distribution of brassy minnow in Alberta.

Alberta

Meristic counts in 15 specimens obtained from Milk River drainage are as follows: scales along lateral line 35-39; above lateral line 6 or 7 (most at 6); around caudal peduncle 16.

Gillrakers on first gill arch: upper arch 2-4; lower arch 7 or 8; total 9-11. The gillrakers are longer and more distinct than on most other Alberta minnows. Vertebral number in 25 specimens from Bare Creek (Milk River drainage) 36-39, with the majority at 37; and in 21 specimens from Musreau Lake 37-40, with the majority at 38.

Maximum length observed for Alberta is 81 mm fork length from Halfbreed Creek near Aden.

Distribution

● Alberta and Colorado to New York; scattered localities in British Columbia near New Westminster and Prince George.

■ Known in Alberta in Milk River drainage (tributaries to the Milk River within Alberta, Lost River, and Lodge Creek), Musreau Lake (south of Grande Prairie in Smoky River drainage), the Athabasca River near and downstream from Fort McMurray, and the House River which is a tributary of the Athabasca River south of Fort McMurray (see Map 12.3).

Biology

Brassy minnows in the Milk River drainage occur in slow currents, including "alkali" streams. They feed primarily on algae. They probably spawn in late spring and summer. Individuals with ripe eggs have been found in July in the Milk River drainage.

Collections made from the Peace and Athabasca river drainages in Alberta (Berry 1977; Bishop 1975b; Bond 1980; Bond and Berry 1980; Griffiths and Ferster 1973; Machiak and Bond 1979; Tripp and McCart 1979), and thought to represent native populations, lend support to the suggestion of McPhail and Lindsey (1970) that the brassy minnow entered the upper Peace River system of British Columbia via Alberta, possibly from the Missouri River system. However, in a detailed study of geographic variation in the species, Wells (1978) showed that there are two forms of brassy minnow and that the form in northern Alberta and British Columbia more closely resembles the Great Lakes form (possibly originating from the Mississippian refugium) than it does the Missouri form. This suggests that our northern populations entered Alberta

via Glacial Lake Agassiz from the Great Lakes—Mississippi area, just the opposite to that suggested for northern pike by Seeb et al. (1987).

Historical Note

C.L. Hubbs first described the brassy minnow in 1929 (holotype not designated by Hubbs, lectotype designated in 1954 by R. M. Bailey from Dead River, Michigan) as *Hybognathus hankinsoni*. It was first noted from Alberta by McAllister (1962) from specimens collected 9 July 1961, in Lodge Creek (southeastern-most Alberta). Willock (1968) and Henderson and Peter (1969) reported additional finds from the Milk River drainage and Violet Scott collected one adult in 1968 in the Lost River southeast of Comrey.

12.4 Pearl Dace
Margariscus margarita (Cope)
(=*Semotilus margarita* (Cope))

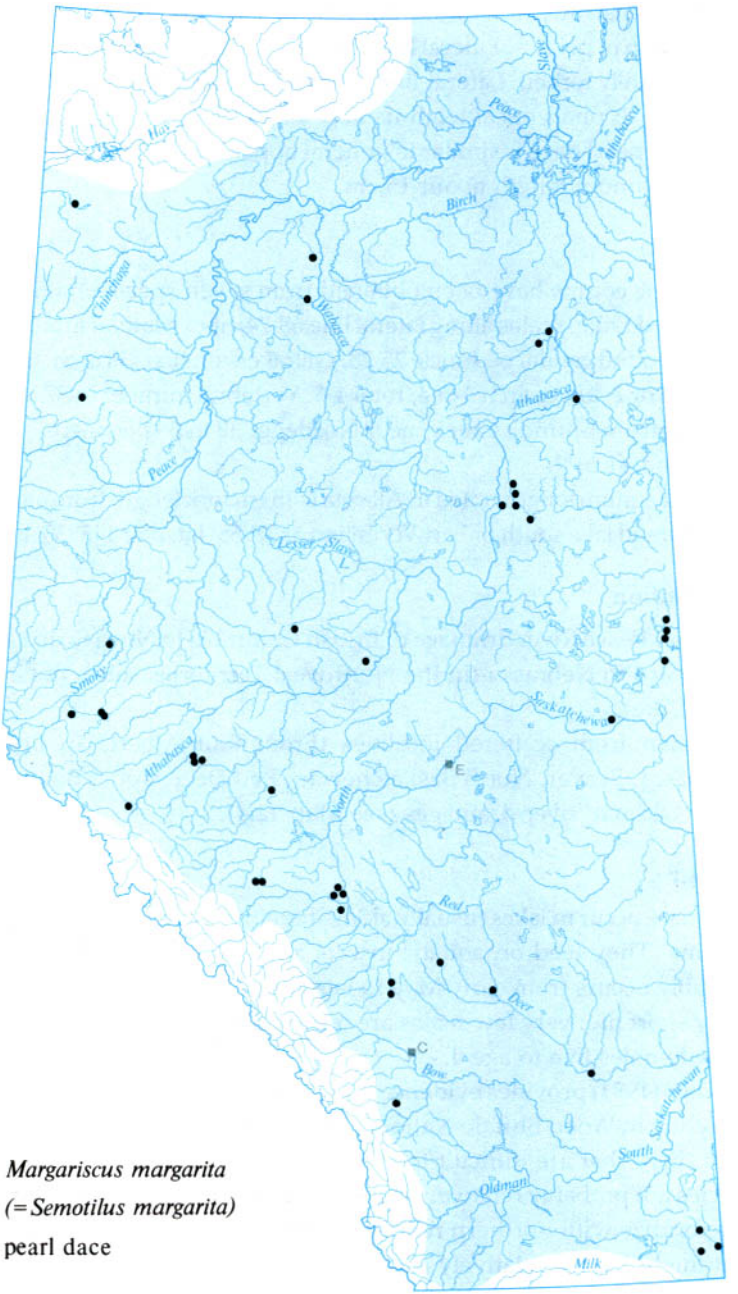
[*Margariscus:* a pearl; *margarita:* a pearl; *Semotilus:* banner (dorsal fin) spotted]

Pearl dace adults from Pierre Greys Lakes, male 7.1 cm standard length on top and female 10 cm standard length on bottom, 1 June 1983. Photo courtesy of E.M. Stinson.

Description

Color: Darkish green or gray dorsally, dusky silver laterally. Young with a distinct brownish-black lateral band, often present posteriorly in adults. Peritoneum somewhat silvery with a few black spots. Males in late fall and until breeding season usually with a bright red band below the lateral line (at least after being caught, color in live individuals may differ); females may have a pale red band.

Body: Slightly compressed. Head conical and moderately rounded dorsally, space between the eyes about 1 1/2 times eye diameter; eyes large; mouth moderate (extending or almost extending to front margin of eye and about equal in length to eye diameter), very slightly subterminal (upper lip projecting slightly in front of lower lip), and slightly oblique; barbels flattened or flap-like (not slender as in other species), inconspicuous (not visible when mouth closed, may be absent on one side), and placed distinctly ahead of end of upper jaw.



Map 12.4 Distribution of pearl dace in Alberta.

Isthmus narrow, about 1/4 width of head. Origin of dorsal fin behind insertion of pelvics. Lateral line complete and decurved. Caudal fin moderately forked. Lateral-line scales 60-75; dorsal and anal fin rays usually 8; pharyngeal teeth usually 2,5-4,2.

The pearl dace is similar in general appearance to the lake chub.

Size: Maximum length about 15 cm.

Alberta

Meristic counts have been obtained from seven specimens caught in Obed Lake: scales along lateral line 68-74; above lateral line 11-13; and around caudal peduncle 25-28. Gillrakers on first gill arch: upper arch 1 or 2; lower arch 3 or 4; total 4-6. Vertebral number in 37 specimens from Shunda Creek, near Nordegg: 39 in 3 specimens, 40 in 25, and 41 in 9.

Maximum length noted in Alberta is 15 cm fork length from a small unnamed lake south of Fort Vermilion at 57°55′ lat. and 115°30′ long.

Distribution

● Lower Peace River drainage of British Columbia to Nova Scotia and southward to Nebraska (in the Northwest Territories south of Great Slave Lake).

■ Known from scattered localities throughout Alberta in Peace, Athabasca, Beaver, North Saskatchewan, Red Deer, upper Bow, and upper Oldman river drainages (see Map 12.4).

Biology

Pearl dace occur in lakes (usually along margins near cover) and in slow streams. They feed on aquatic insects and zooplankton. Spawning probably occurs from early May to late June. This species has a relatively short life; very few males are reported to live to age 3 and only a few females live to age 4.

Wells (1981) provides evidence that this species may hybridize with lake chub in Wood Buffalo National Park; at least there are specimens from there that are difficult to identify to either species. These two species are probably relatively closely related. Pearl dace are reported to hybridize with northern redbelly dace elsewhere, another species that might have a relatively close affinity.

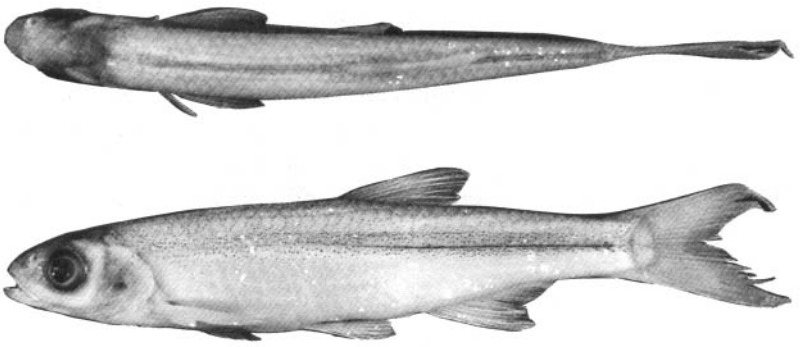
Historical Note

E.D. Cope first described pearl dace in 1869 from the Conestoga River, Pennsylvania, as *Clinostomus margarita*. It was first noted in Alberta by Bajkov (1927) from the Athabasca River and beaver dams near Jasper as a new subspecies, *Leuciscus nachtriebi athabascae;* it would be desirable to confirm the distinctiveness of this form. Miller and Macdonald (1950) subsequently noted the species next from Goldeye and Obed lakes.

Several subspecies are sometimes recognized. If valid, our subspecies is the wide ranging *M. margarita nachtriebi*. This species has recently been referred to as *Semotilus margarita*. However, as noted in Robins et al. (1991), its relationships are probably with *Couesius* and *Phoxinus* and not with species of *Semotilus*. The monotypic genus *Margariscus* is resurrected until its relationships are better known.

12.5 Emerald Shiner *Notropis atherinoides* Rafinesque

[*Notropis:* back keel (the keel was presumably a deformity in a shriveled specimen); *atherin oides:* silverside resemblance]

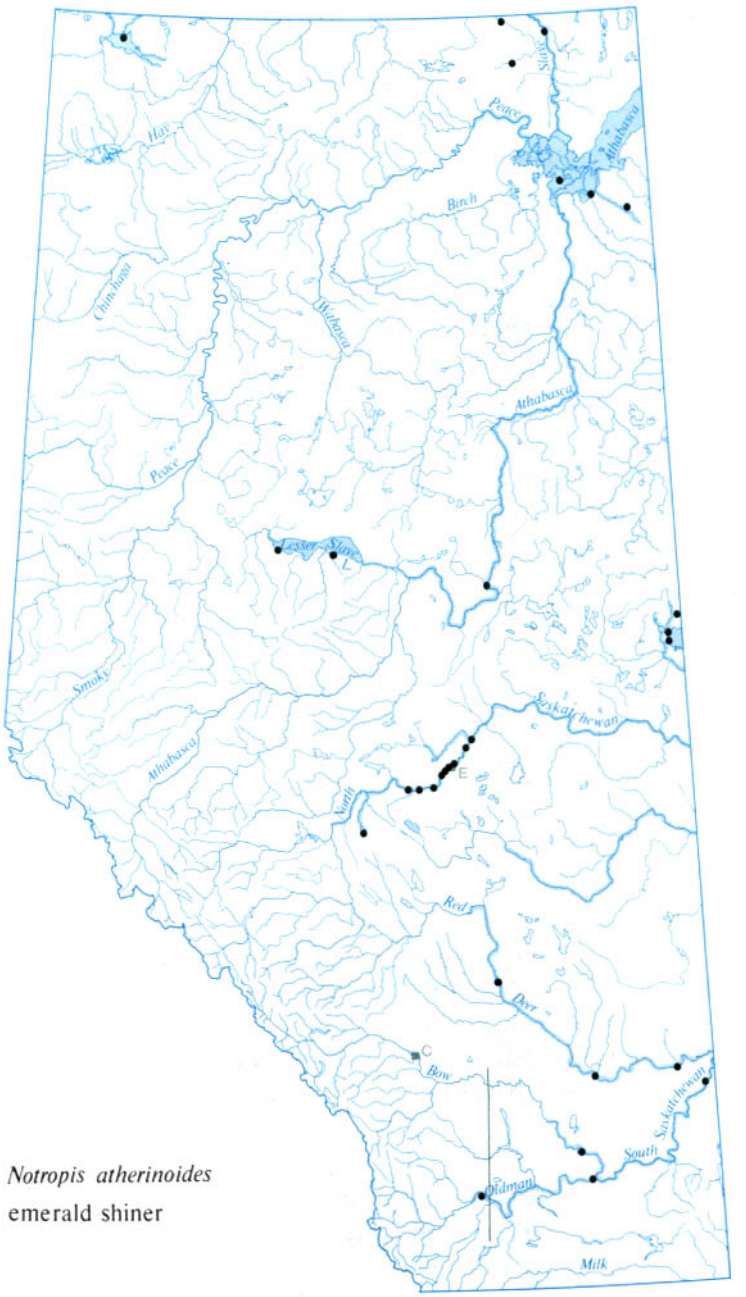


Emerald shiner adults, 57 mm standard length, from North Saskatchewan River at Fort Saskatchewan.

Description

Color: Body yellowish silver with bluish-purple iridescence, somewhat translucent. Shining silvery lateral band (appearing blackish in preserved specimens). Gill cover shiny silvery. Peritoneum silvery, with numerous small black spots. Breeding individuals devoid of color other than as noted above.

Body: Strongly compressed (but not as deep-bodied as redside shiners). Head conical and strongly rounded dorsally; distance between eyes about 1 to 1 1/4 times eye diameter; eyes large; mouth large (extending or almost extending to front margin of eye and equal or greater in length than eye diameter), terminal and slightly oblique; barbels absent. Isthmus narrow, about 1/4 width of head. Origin of dorsal fin behind insertion of pelvics. Lateral line complete and moderately decurved. Caudal fin moderately forked. Lateral-line scales 35-41; scales above lateral line about 6-8 and around caudal peduncle about 13 or 14 (the scales of this species are easily lost); dorsal fin rays 8 and anal fin rays 9-13; gillrakers about 9-12 (the gillrakers are longer and



Map 12.5 Distribution of emerald shiner in Alberta.

more distinct than on most other Alberta minnows); pharyngeal teeth usually 2,4-4,2.

Small tubercles on the pectoral fin are most noticeable on breeding males.

Size: Maximum length 12 cm.

Alberta

The number of rays in the anal fin is quite variable although most commonly 11; in contrast, the dorsal fin almost always has 8 rays. The frequency distribution of the number of anal fin rays from specimens from nine locations is as follows:

	Number of anal fin rays				
	9	10	11	12	13
Salt River (59°58'N)	-	-	8	2	-
Athabasca River Delta	-	-	8	-	-
Lesser Slave Lake	-	2	8	-	-
Cold Lake	-	4	35	1	-
North Saskatchewan River, near Edmonton	-	1	24	11	-
Buck Lake	-	9	11	-	-
Pigeon Lake	2	24	14	-	-
Red Deer Drainage	-	1	5	2	-
South Saskatchewan River	-	3	12	6	1

Vertebral number in 180 specimens from the Athabasca Delta to the South Saskatchewan River ranges from 39 to 44 and does not show any obvious clinal variation. The frequency of counts: 39 in 2 specimens, 40 in 22, 41 in 74, 42 in 74, 43 in 7, and 44 in 1.

Maximum length observed for Alberta is 11 cm fork length from Big Island, North Saskatchewan River, near Edmonton.

Distribution

● Fort Nelson, British Columbia and Mackenzie River (rare) to Quebec and New York to southeastern Texas.

■ Widespread in much of Alberta in Petitot, Slave, lower Peace, Athabasca, North Saskatchewan, Beaver, Red Deer, South Saskatchewan, lower Bow, and Oldman river drainages (see Map 12.5). A single

specimen is known from the lower Milk River in Alberta; they are known from the Milk River drainage in Montana.

Biology

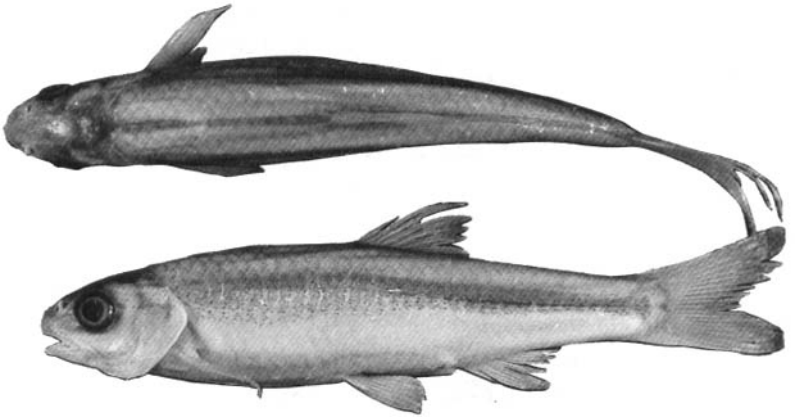
Emerald shiners are usually most common in large rivers and in large lakes. They tend to be surface swimming, occurring offshore during the summer months more so than most of our other minnows. They feed predominantly on zooplankton (e.g., small crustaceans) but also on algae. In turn, they are an important food item for other fish and for fish-eating birds, their occurrence near the surface making them particularly vulnerable to the latter. Spawning probably occurs from June to August with a 3-year maximum life span.

Historical Note

C.S. Rafinesque first described the emerald shiner in 1818 from Lake Erie as *Notropis atherinoides*. It is the type species for the exceptionally large North American genus *Notropis*, which contains about 90 species. It was first noted in Alberta by Eigenmann (1895) at Medicine Hat and was recorded from Lake Athabasca by Kendall (1924)

12.6 River Shiner *Notropis blennius* (Girard)

[*Notropis:* back keel (the keel was presumably a deformity in a shriveled specimen); *blennius:* blenny (an eellike marine fish)]



River shiner adults, 57 mm standard length, from North Saskatchewan River at Fort Saskatchewan.

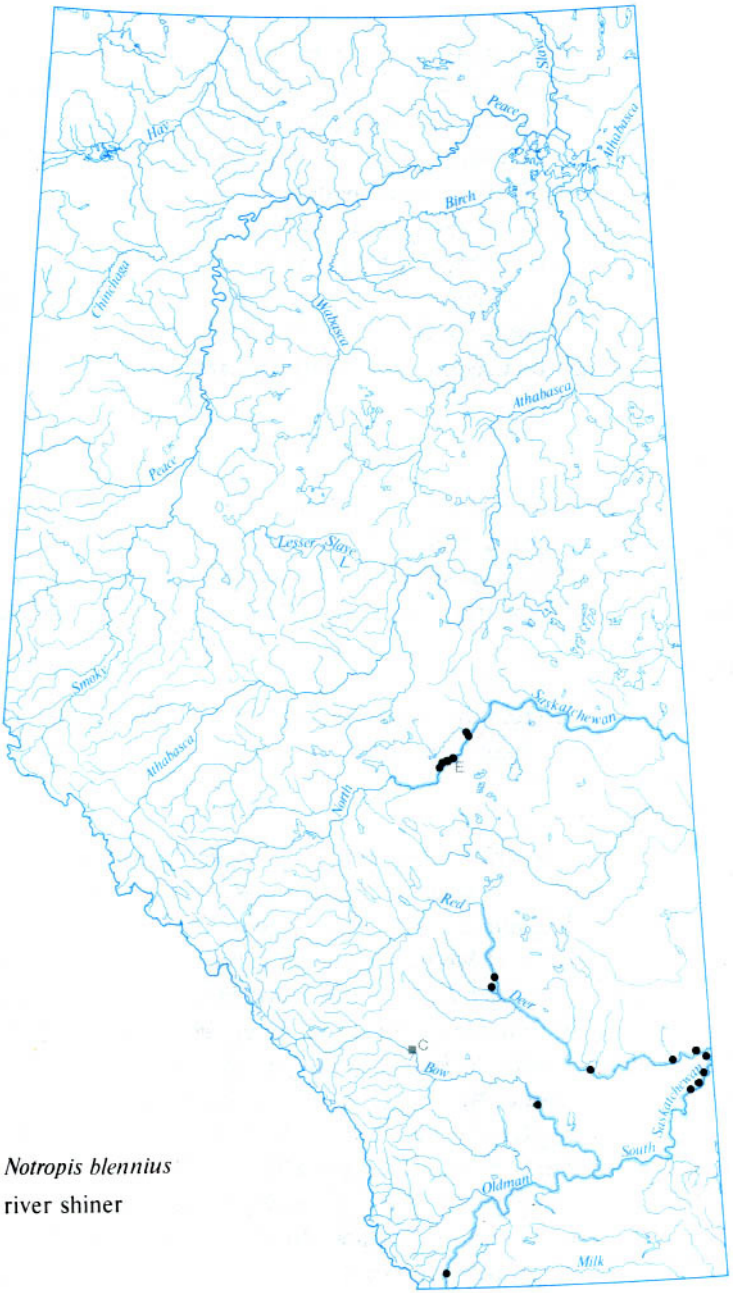
Description

Color: Basically silvery but olive-straw to light brown dorsally. Silvery to lead-colored lateral band (a darkish band appears in preserved specimens). No spot at the base of the caudal fin. Peritoneum silvery with few or no black spots.

Body: Moderately compressed. Head conical and slightly rounded dorsally; distance between eyes about 1 1/2 times eye diameter; eyes moderate; mouth moderate (usually not extending to front margin of eye but longer than eye diameter), slightly subterminal and slightly oblique; barbels absent. Isthmus narrow, about 1/4 width of head. Origin of dorsal fin about even with or slightly in front of insertion of pelvic fins. Lateral line complete and decurved. Caudal fin moderately forked. Lateral-line scales 34-37; dorsal fin rays 8 and anal fin rays usually 7; pharyngeal teeth 1 or 2,4-4,2 or 1.

Breeding males with tiny tubercles on the pectoral fins.

Size: Maximum length 13 cm.



Map 12.6 Distribution of river shiner in Alberta.

Alberta

Meristic counts in 20 specimens obtained from the North Saskatchewan River, near Edmonton, are as follows: scales along lateral line 34-37 (most have 35 or 36); above lateral line 5 or 6; around caudal peduncle 11 or 12. Gillrakers on first gill arch: upper arch 2 or 3; lower arch 4-6; total 6-8. Pharyngeal teeth in five specimens 2,4-4,2. Anal fin with 7 rays in 18 specimens and 8 rays in 2. Vertebral number in 99 specimens from North Saskatchewan and Red Deer river drainages: 36 in 9 specimens, 37 in 60, and 38 in 30.

Maximum length noted in Alberta is 9.8 cm fork length at the junction of Whitemud Creek and the North Saskatchewan River, Edmonton (UAMZ 6819).

Distribution

● Alberta to eastern Manitoba and Oklahoma to Pennsylvania.

■ Sporadic in central and southern Alberta. Occur in the North Saskatchewan (near Edmonton and downstream), Red Deer, lower Bow, lower Oldman, and South Saskatchewan rivers (see Map 12.6).

Biology

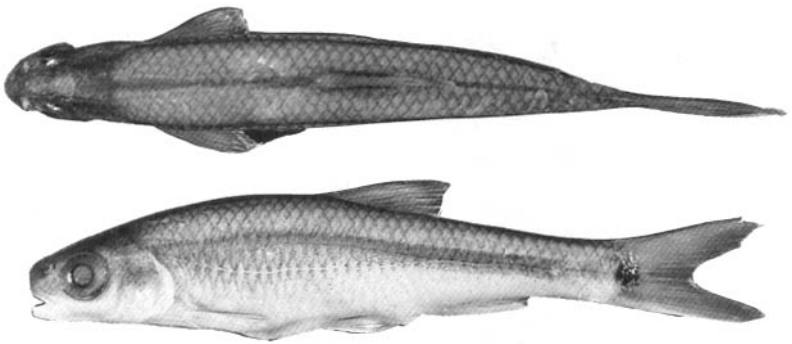
River shiners are commonest in large streams over sandy and gravel bottoms. They probably spawn in July and August.

Historical Note

C.F. Girard first described the river shiner in 1856 from the Arkansas River, Arkansas, as *Alburnops blennius*. It was first noted in Alberta by Eigenmann and Eigenmann (1893) and Eigenmann (1895) in the South Saskatchewan River at Medicine Hat as the type for the new species, *Notropis jordani* (= *N. albeolus* Eigenmann and Eigenmann), on the basis of one individual 73 mm long and also by Eigenmann (1895) at Medicine Hat as *Notropis jejunus*. *N. jordani* was regarded as allied to *N. heterodon* which gets as close to Alberta as Manitoba and North Dakota. It has been considered as conspecific with *N. heterolepis* (see Appendix I) but is now considered to be conspecific with *N. blennius* (Gilbert 1978: 23,52); the type specimen from Medicine Hat is deposited at the Museum of Natural History in London, England. In Paetz and Nelson (1970) we felt that *N. jordani* probably represented a species known from Alberta and such seems to be the case. The river shiner was further collected in 1914 from Morrin, Red Deer River drainage (McAllister 1962).

12.7 Spottail Shiner *Notropis hudsonius* (Clinton)

[*Notropis:* back keel (the keel was presumably a deformity in a shriveled specimen); *hudsonius:* after the Hudson River]



Spottail shiner adults, 57 mm standard length, from Beaver Lake.

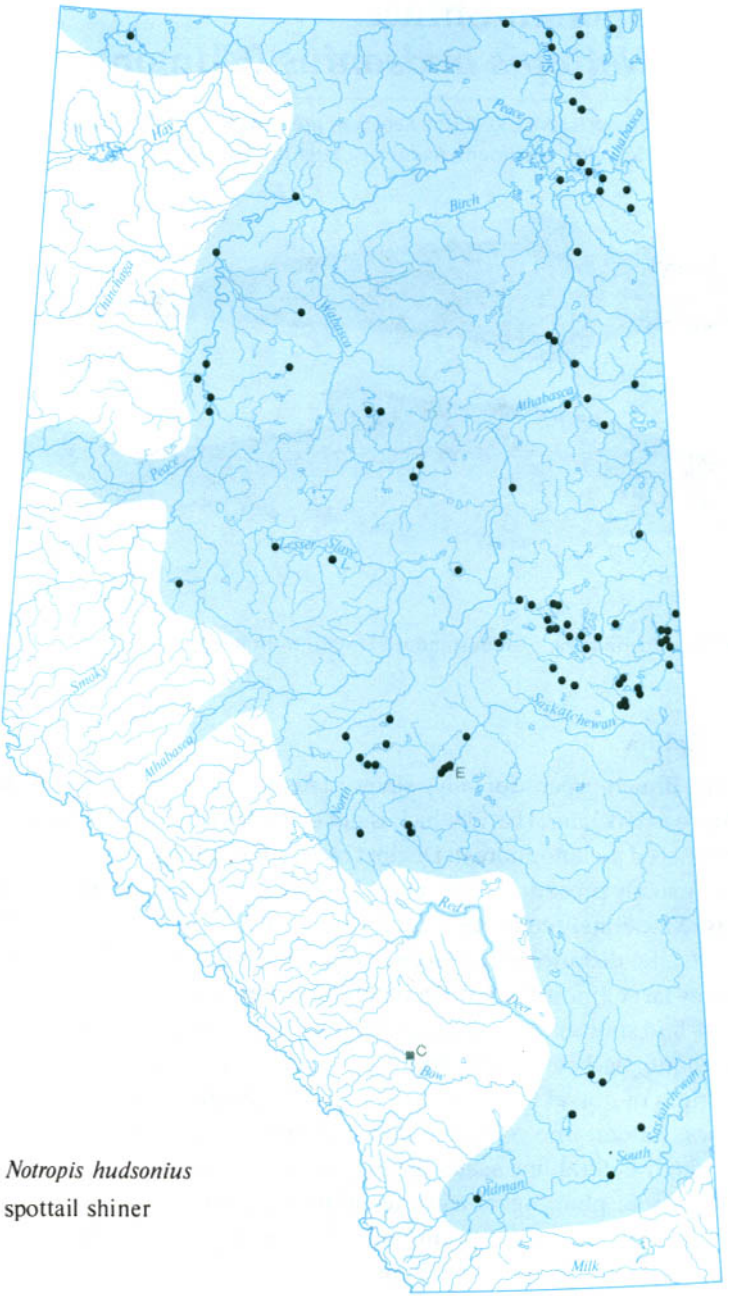
Description

Color: Bluish-green dorsally, silvery laterally. Preserved specimens have a dark lateral band which is not evident in living fish (except for scattered melanophores). Distinct black spot at the base of the caudal fin usually present. Peritoneum silvery with a few small black spots.

Body: Moderately compressed. Head conical and moderately rounded dorsally; distance between eyes about 1 to 1 1/4 times eye diameter; eyes large; mouth small (usually not extending to front margin of eye and shorter than eye diameter), slightly subterminal and slightly oblique; barbels absent. Isthmus narrow, about 1/4 width of head. Origin of dorsal fin even with or slightly ahead of insertion of pelvics. Lateral line complete and decurved. Caudal fin moderately forked. Lateral-line scales 36-40; dorsal fin rays 8 and anal fin rays usually 8; pharyngeal teeth usually 1 or 2,4-4,2 or 1.

Breeding males with tiny tubercles on the pectoral fin.

Size: Maximum length 14 1/2 cm.



Map 12.7 Distribution of spottail shiner in Alberta.

Alberta

Meristic characters were determined in a number of locations. Scales (Beaver Lake): along lateral line 36-40 (most have 38); above lateral line 6; around caudal peduncle 12. Gillrakers (four lakes) on first gill arch: upper arch 1 or 2; lower arch 3-7; total 4-9. Anal fin ray number (eight scattered localities): 7 in 4 specimens, 8 in 120, and 9 in 6. Vertebral number in 137 specimens: 37 in 7 specimens, 38 in 73, 39 in 54, and 40 in 3.

Maximum length observed for Alberta is 10 cm fork length from Lac Ste. Anne.

Distribution

● Alberta and the Northwest Territories to Quebec with southward extension to Kansas and Georgia.

■ Widespread in Alberta in Petitot, Slave, Peace, Athabasca, North Saskatchewan, Beaver, Red Deer, South Saskatchewan, Bow, and Oldman river drainages (see Map 12.7).

Biology

The spottail shiner is common in lakes and streams. In some northern Alberta lakes it is one of the most important fish prey species for northern pike, percids, etc., as well as for fish-eating birds. Large schools are often found well out in the open water of lakes. They feed on plankton (small crustaceans and algae), aquatic insects, and bottom fauna. Their life span is 4 or 5 years and spawning probably occurs from June to August. The eggs are less than 1 mm in diameter. The schooling behavior of this species in Beaver Lake, near Lac La Biche, is discussed by Nursall (1973). In that paper Dr. Nursall suggests that the black spot on the caudal peduncle may serve several functions: i) a recognition mark used by members of the same species in maintaining a school, ii) a false eye serving to confuse predators, and iii) an easily seen visual signal that allows other shiners to detect the rapid movement of one of them in response to a predator. The young of many other minnows also have a black spot (e.g., squawfish) and these same functions may also apply in them.

Larvae of the large tapeworm *Ligula intestinalis* often occur in the spottail shiner. *Neascus*, a trematode larvae which produces "black spot" in the skin, and other trematode larvae which live in the brain are also frequently found. The latter can be quite harmful to the fish.

Historical Note

DeWitt Clinton first described the spottail shiner in 1824 from the Hudson River, New York, as *Clupea hudsonia*. It was first noted in Alberta by Eigenmann and Eigenmann (1893) and Eigenmann (1895) at Medicine Hat as *Notropis scopiferus*. One small specimen taken at Fort Chipewyan, Lake Athabasca, in 1914 was described as a new species, *Opsopoeodus borealis* (Harper and Nichols 1919). Spottail shiners collected in Lake Athabasca in 1920 were referred to as the subspecies *Notropis hudsonius selene* (Kendall 1924).

12.8 Northern Redbelly Dace *Phoxinus eos* (Cope)

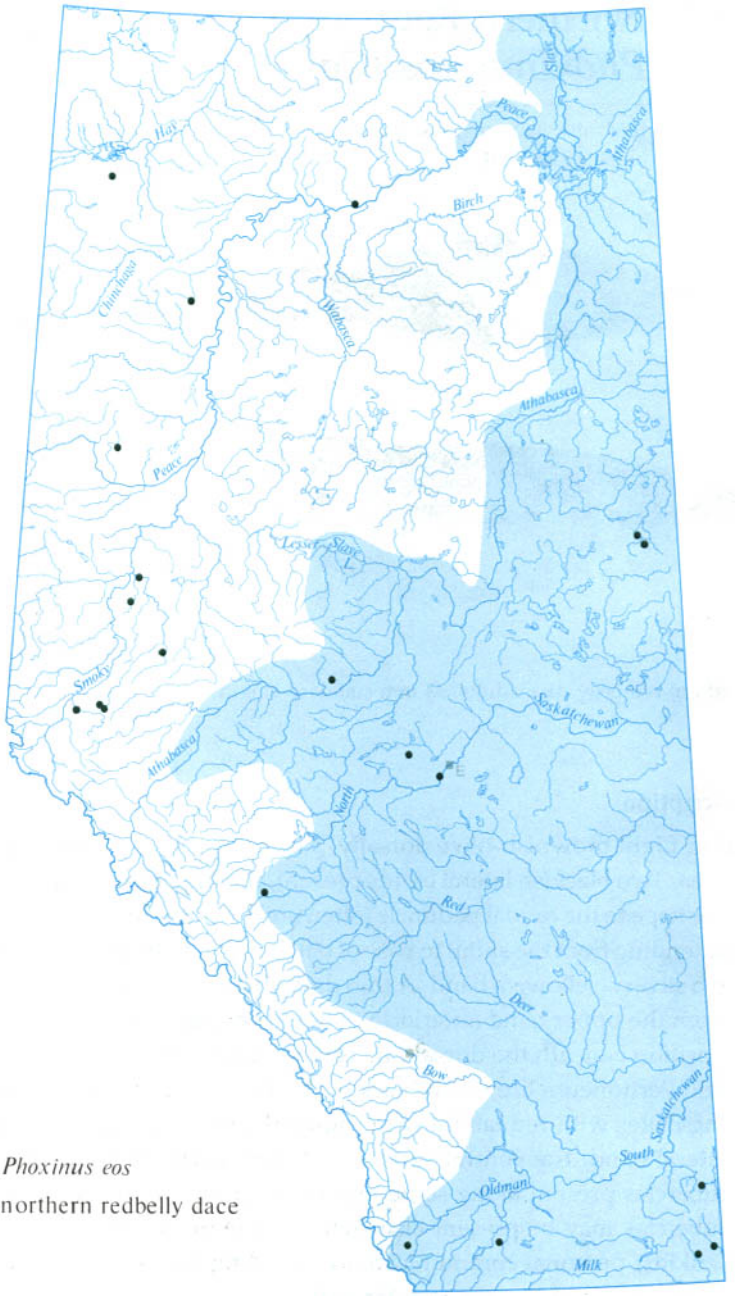
[*Phoxinus:* tapering; *eos:* sunrise (in reference to color patterns in breeding males)]

Northern red belly dace adults, 44 mm standard length, from Summit Lake.

Description

Color: Light brownish-olive dorsally, silvery or yellowish on ventral area. Two blackish lateral bands present, the upper extending from the nape to the caudal peduncle (often broken posteriorly), the lower extending from the snout to base of tail. Between the two dark bands is a silvery-yellowish band. A thin dark oblique line usually extends from the upper band anteriorly to the lower band posteriorly, in a position beneath the dorsal fin. Young with a dark spot on base of tail. Peritoneum brownish-black with a faint trace of silver. Breeding males with red lateral stripe along the side beneath the lower lateral band, the ventral surface and most of the fins are yellow; tubercles present along some rays of the pectoral fin, some small tubercles may be present elsewhere on the head and body (R.E. Jenkins, personal communication). Breeding females may have a faint version of the above color pattern.

Body: Rounded in section. Head short, conical, and slightly rounded dorsally, space between eyes about 1 1/2 times eye diameter; eyes



Map 12.8 Distribution of northern redbelly dace.

moderate; mouth small (not extending to front margin of eye and slightly shorter than eye diameter), terminal or with lower lip tending to project in front of upper lip, and very oblique; barbels absent. Isthmus moderate, between 1/3 and 1/4 width of head. Origin of dorsal fin behind insertion of pelvics. Lateral line incomplete, often only a few pored scales and ending under the pectoral fin. Intestine elongate, usually 1 main loop and 2 coils. Caudal fin moderately forked. Lateral-line scales about 66-90, usually more than 75 (these scales are so small that a microscope is usually required to see them); scales around caudal peduncle about 21-25; dorsal and anal fin rays usually 8; pharyngeal teeth usually 0,5-4,0 or 0,5-5,0; first arch gill-rakers about 8-11.

Size: Maximum length 7 1/2 cm.

Alberta

Vertebral number in 25 specimens from Cameron lake, near Edmonton: 36 in 3 specimens, 37 in 21, and 38 in 1.

Maximum length observed for Alberta is 6 cm fork length from Beauvais Lake. This species is smaller than the other species placed in the same genus, *P. neogaeus*.

Distribution

● Northeastern British Columbia and southwestern Northwest Territories to New Brunswick and southward to Wisconsin; in New Mexico.
■ Known from scattered localities throughout much of Alberta from Hay, Peace, Athabasca, North Saskatchewan, Oldman, South Saskatchewan, and Milk river drainages (see locality records on Map 12.8); it is inferred to be in the Red Deer River drainage from the suspected presence of hybrids between this species and the finescale dace.

Biology

Northern redbelly dace occur in lakes and streams. They feed primarily on algae (primarily green algae) and zooplankton. Spawning occurs over aquatic plants in June and July. Northern redbelly dace hybridize with finescale dace throughout much of their common range (i.e., area of sympatry) from eastern to western North America. Das (1986) and Das and Nelson (1989, 1990) report extensive hybridization in one such area of Alberta, Upper Pierre Greys Lake near Grande Cache. Here, about 33% of the individuals of *Phoxinus* are hybrids and all hybrids are female. It is possible that the hybrids reproduce; the females may

form a hybrid species but require sperm from one of the parental species to initiate embryological development as has been found in eastern North America (Goddard and Dawley 1990). Hybridization is suspected to occur in several other localities in Alberta, and a hybrid swarm appears to be present in an oxbow lake near the mouth of the Medicine River (M.K. Das and W.E. Roberts, personal communication).

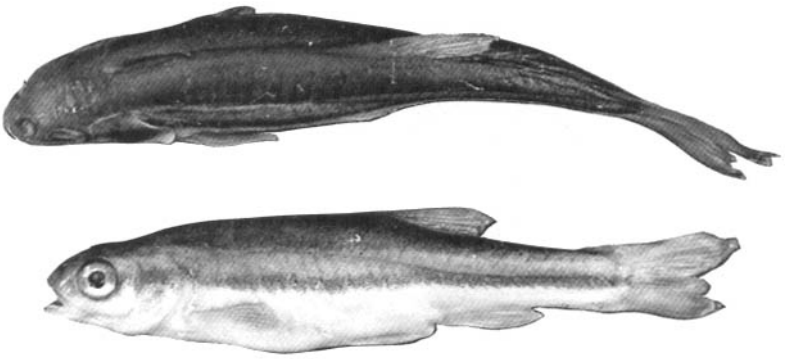
Historical Note

E.D. Cope first described the northern redbelly dace in 1861 from Susquehanna River, Pennsylvania, as *Chrosomus eos*. It was first reported from Alberta by Miller and Macdonald (1950) from Battle Creek (Cypress Hills) and Beauvais Lake.

In the first edition of this book we placed this and the next species, *P. neogaeus*, in the North American endemic genus *Chrosomus* (meaning "colored body"). However, both species are now considered by most workers to be congeneric with the Eurasian species of *Phoxinus*. These names were first used at the generic level at the same time (in 1820) by C.S. Rafinesque (companion of J.J. Audubon and described as "a gullible genius and eccentric naturalist") in his "Ichthyologia Ohiensis". The generic name *Phoxinus* was adopted over *Chrosomus* by the person first proposing the lumping, P. Banarescu, in 1964.

12.9 Finescale Dace *Phoxinus neogaeus* Cope

[*Phoxinus:* tapering; *neo gaeus:* new world]

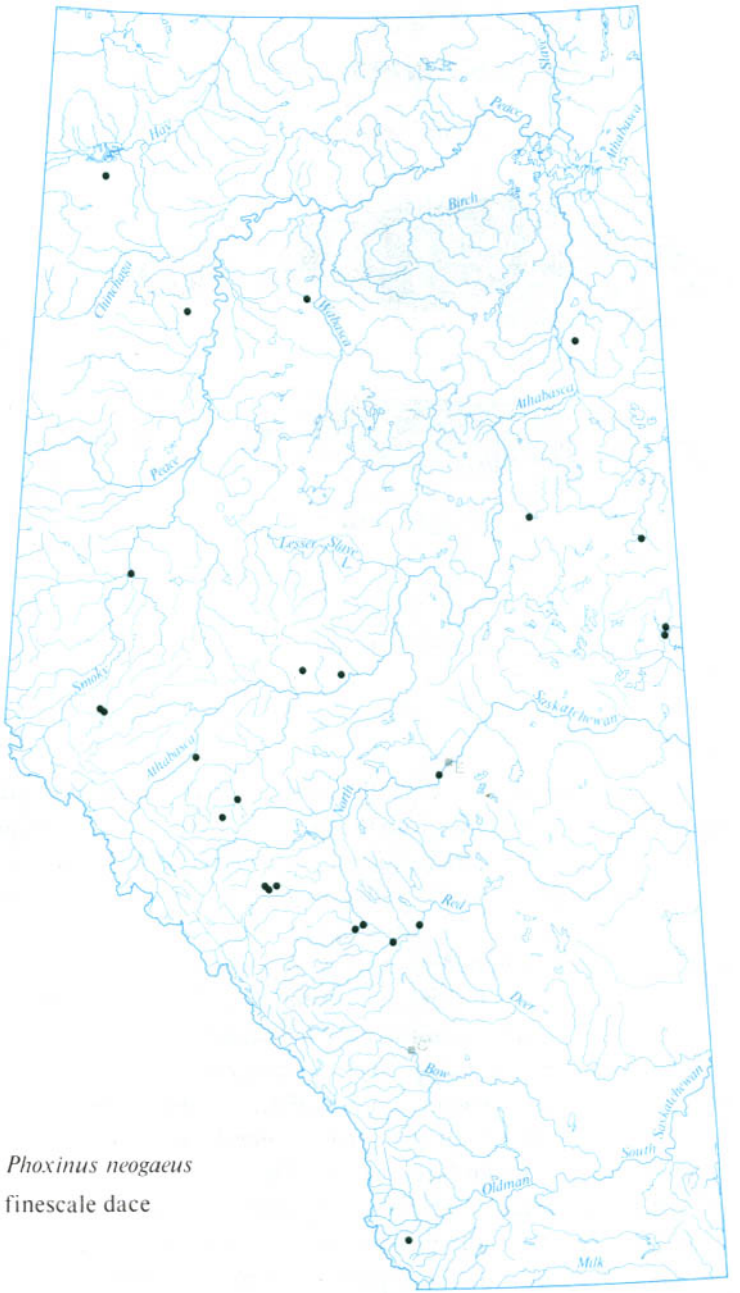


Finescale dace adults, 52 mm standard length, from Summit Lake.

Description

Color: Dark brownish-olive dorsally, silvery on ventral area. A single dark lateral band extends from the gill cover to the tail, in the same position as the lower dark band in the northern redbelly dace (*Phoxinus eos*). Above this band is a silvery-yellowish band, above which there is only a faint trace of the upper darkish band present in *P. eos*. A thin dark oblique line usually extends from the upper dark area anteriorly to the lower band posteriorly, in a position beneath the dorsal fin. Young with the dark lateral band distinct and with a dark spot on the caudal peduncle. Peritoneum brownish-black to blackish with silvery sheen underneath (and much paler than in *P. eos*). Breeding males with faint yellow lateral stripe along the side beneath the lateral band, most of the fins are yellow; tubercles or smooth-surfaced padlike ridges are present along some rays of the pectoral fin, some small tubercles may be present elsewhere on the head and body (R.E. Jenkins, personal communication). Breeding females may have some yellow color.

Body: Rounded in section. Head moderate (longer than in *P. eos*), and slightly rounded dorsally, space between eyes about 1 1/2 times eye



Map 12.9 Distribution of finescale dace in Alberta.

diameter; eyes moderate; mouth moderate (larger than in *P. eos*), extending or almost extending to front margin of eye and about equal in length to eye diameter, terminal and moderately oblique; barbels absent. Isthmus moderate, between 1/3 and 1/4 width of head. Origin of dorsal fin behind insertion of pelvics. Lateral line incomplete, ending under or before the dorsal fin. Intestine short, 1 main loop. Caudal fin moderately forked. Lateral-line scales about 65-90 (so small that a microscope is usually required to see them); scales around caudal peduncle about 34-37; dorsal and anal fin rays usually 8; pharyngeal teeth usually 2,5-4,1; 2,5-4,2 or 2,5-5,2; first arch gill-rakers about 8-10.

Size: Maximum length 10 1/2 cm.

Alberta

Vertebral number in 25 specimens from Tay Lake, Alberta: 36 in 1 specimen, 37 in 0, 38 in 16, 39 in 7, and 40 in 1.

Maximum lengths observed for Alberta are 8.1 cm fork length from the Lovett River in the Pembina River drainage (UAMZ 4322) and 7.5 cm fork length from Beauvais and Tay lakes.

Distribution

● Northeastern British Columbia, Alberta, and northward down the Mackenzie River drainage; Saskatchewan to New Brunswick and eastern Wyoming to Northern New York.

■ Known in Alberta from a few scattered localities in the Hay, Peace, Athabasca, Beaver, upper North Saskatchewan, and Oldman river drainages (see Map 12.9); it is inferred to be in the Red Deer River drainage from the presence of fish that are suspected to be hybrids between this species and the northern redbelly dace.

Biology

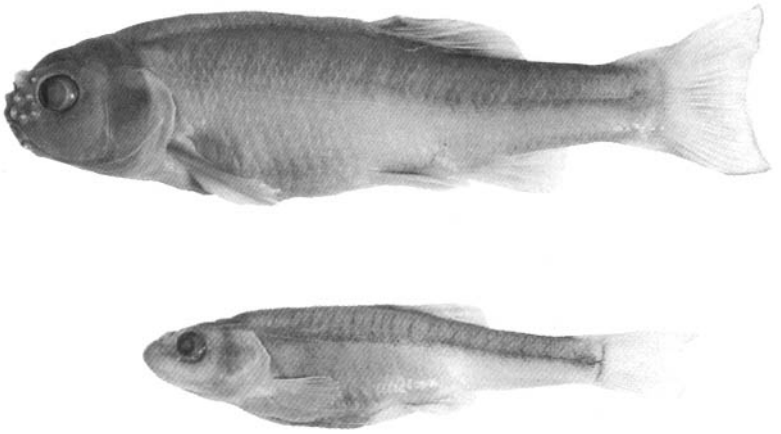
Finescale dace occur in lakes and sluggish creeks. It is usually larger than the redbelly dace in sympatric situations. Their diet consists primarily of insects and other aquatic invertebrates; some algae is also consumed. Finescale dace mate in an embrace under debris such as submerged logs and brush piles (Stasiak 1978). About 20 to 30 eggs are released with each embrace. Finescale dace hybridize with northern redbelly dace throughout much of their area of common range (see comments under northern redbelly dace). Das (1986) and Das and Nelson (1989, 1990) give additional information on this species and the hybrids.

Historical Note

E.D. Cope first described the finescale dace in 1866 from New Hudson, Michigan, as *Phoxinus neogaeus*. It was first taken in Alberta in the collection of R.E. Ayling, June 16, 1956, from Beauvais Lake. This species was not distinguished from *Phoxinus eos* in Alberta until the 1960s. It is placed in the monotypic genus *Pfrille* or the polytypic North American genus *Chrosomus* by some workers.

12.10 Fathead Minnow *Pimephales promelas* Rafinesque

[*Pime phales:* fat head; *pro melas:* before black]

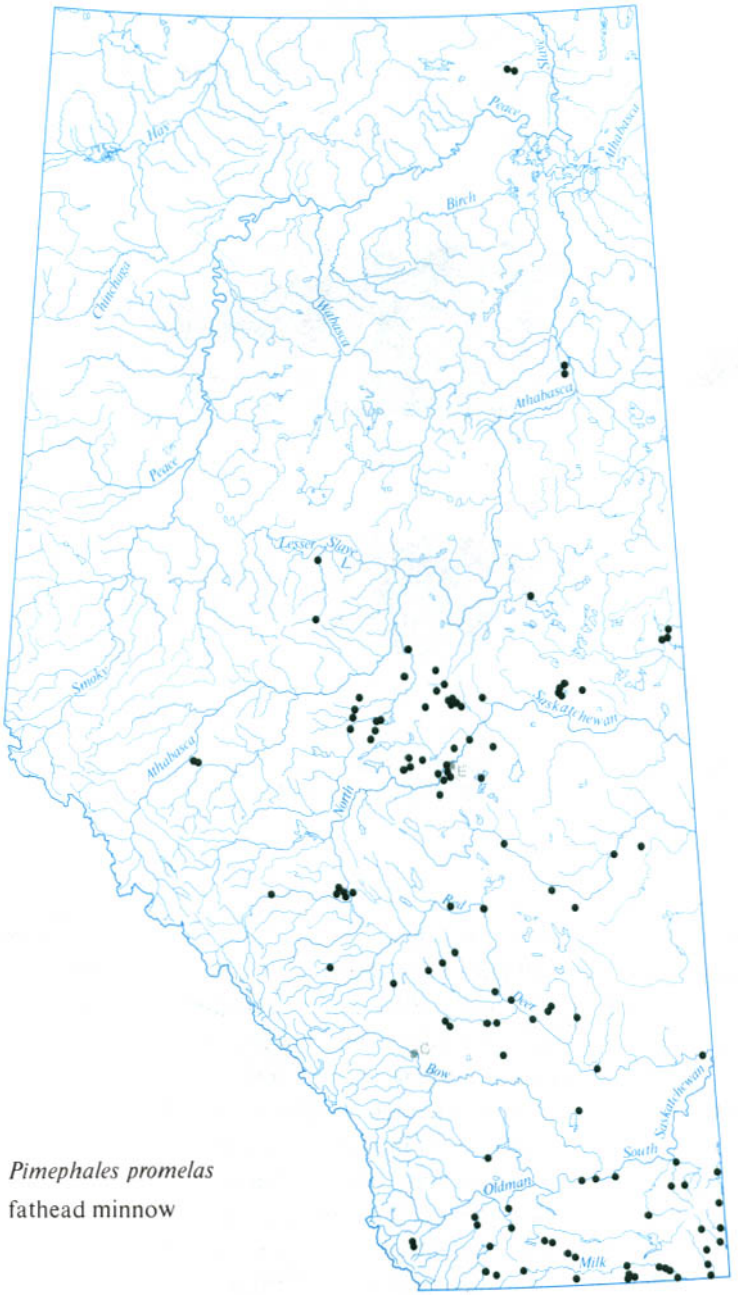


Fathead minnow adults (UAMZ 6719), mature male (top) and mature female (bottom), from Astotin Lake, Elk Island National Park.

Description

Color: Olive-yellow to straw-yellow dorsally and laterally, and yellow-silvery underneath (sides not glistening silvery as is characteristic of most Alberta minnows). Blackish lateral band from gill cover to tail (sometimes very faint, most distinct in young). Peritoneum black, occasionally with some silver showing through. Breeding males with black head and large black spot at anterior base of dorsal fin (spot may be diffuse and faint in immature males).

Body: Slightly to moderately compressed. Head blunt in breeding males (hence the common name of the species), conical in others, strongly rounded dorsally in breeding males, moderately so in others; distance between eyes about 1 3/4 to 3 1/2 times eye diameter; eyes moderate to small; mouth small (not extending to front margin of eye and about equal in length to eye diameter), slightly subterminal to terminal, and slightly oblique; barbels absent. Isthmus moderate



Map 12.10 Distribution of fathead minnow in Alberta.

to wide, about 1/3 to 1/2 width of head. Origin of dorsal fin above or slightly in front of insertion of pelvic fins. Lateral line incomplete, almost complete in many specimens although faint in places, slightly decurved. Intestine long and coiled, several loops crossing ventral midline. Caudal fin moderately forked. Scales in lateral-line series 41-50; scales before the dorsal fin crowded and much smaller than those along the side; dorsal fin rays usually 8 and anal fin rays 7 (anal fin exceptionally small, especially in immatures); pharyngeal teeth 0,4-4,0.

Breeding males with numerous horny tubercles in 3 rows around the snout and usually 2 tubercles under the lower jaw; they also have a thick puffed-out spongy area extending from the nape to the front of the dorsal fin, and the first dorsal fin ray is a conspicuous blunt half-ray that is separated from the first principal ray by a membrane. Adult females have an enlarged urogenital structure, called an "ovipositor" for depositing eggs onto the underside of rocks or logs.

Size: Maximum length about 9 cm.

Alberta

Meristic counts were obtained in Alberta from Verdigris Lake, Milk River drainage (10 specimens). Scales along lateral line 45-50; above lateral line 9-11; around caudal peduncle 19-21. Gillrakers on first gill arch: upper arch 2 or 3; lower arch 10-12; total 12-15. Vertebral number in 271 specimens from five localities, Milk River to Wood Buffalo National Park: 36 in 1 specimen, 37 in 80, 38 in 159, 39 in 30, and 40 in 1.

Maximum length observed for Alberta is 9.3 cm fork length from Cameron Lake, northwest of Edmonton (UAMZ 6356).

Distribution

● Alberta to Quebec to northeastern Mexico.

■ Widespread in central and southern Alberta in the Athabasca, North Saskatchewan, Battle, Red Deer, Bow, South Saskatchewan, Oldman, and Milk river drainages.

The species is also known from Pine Lake in Wood Buffalo National Park and other waters of the Slave River drainage west and south of Fort Smith (see Map 12.10). McPhail and Lindsey (1970) and Scott and Crossman (1973) show the fathead minnow from the Peace River in western Alberta, where sparse populations may indeed exist, but we lack records of it; Bishop (1975a) also failed to find it in this area. However, it does occur in the Peace River drainage at One Island Lake,

southwest of Tupper, British Columbia (Smith and Lamb 1976); it is not known if this population is introduced or native. Fathead minnows have probably been introduced into many waters within their native range east of the Rocky Mountains due to their popularity as a bait fish. Populations found west of the Rocky Mountains (e.g., California) are a result of introductions.

Biology

Fathead minnows often occur in large numbers in muddy creeks, ponds, and lakes. Individuals are frequently found with brook sticklebacks and are quite tolerant to extremes in pH and salinity; both species often occur in areas where other fish could not survive. The fathead minnow feeds primarily on algae but also takes zooplankton and aquatic insect larvae. Price et al. (1991) studied one Alberta population in which invertebrate taxa such as crustaceans and chironomid pupae are the main items consumed. In turn, fathead minnows are important in the diets of piscivorous fishes and birds.

Fathead minnows live in quiet shallow water and are an excellent species for natural history observations. Their spawning behavior is particularly interesting and extends from June until August. The male selects a spawning site on the underside of a log, branch, or rock in water less than a meter deep. A female attracted to the area takes a position below the nesting site where she is nudged by the male to lie on her side. In spawning season the female has a prominent ovipositor in the anal region which is used to deposit the sticky eggs to the underside of the chosen object. The male guards the eggs, driving off intruding small fish. The male also cleans the eggs with the thick spongy pad on his back. Their spawning behavior, as observed in Obed Lake between Edson and Hinton, is described by Miller (1962:167-168).

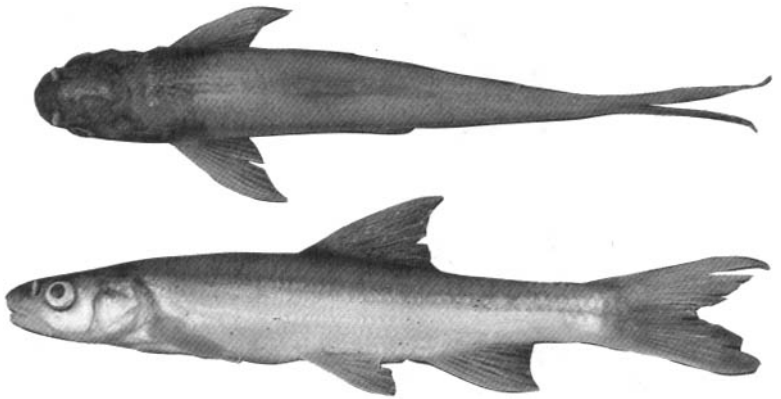
The life history of fathead minnows and the occurrence of alarm substance cells (see comments under family description) has been studied by Dr. Jan Smith and his students in Saskatoon (see, e.g., McMillan 1973; Smith 1976, 1978; Smith and Murphy 1974).

Historical Note

C.S. Rafinesque first described the fathead minnow in 1820 from near Lexington, Kentucky, as *Pimephales promelas*. It was first noted from Alberta at Medicine Hat by Eigenmann (1895).

12.11 Flathead Chub *Platygobio gracilis* (Richardson)

[*Platy gobio:* broad, a gudgeon (a European minnow); *gracilis:* slender]



Flathead chub adults, about 70 mm standard length, from Little Smoky River.

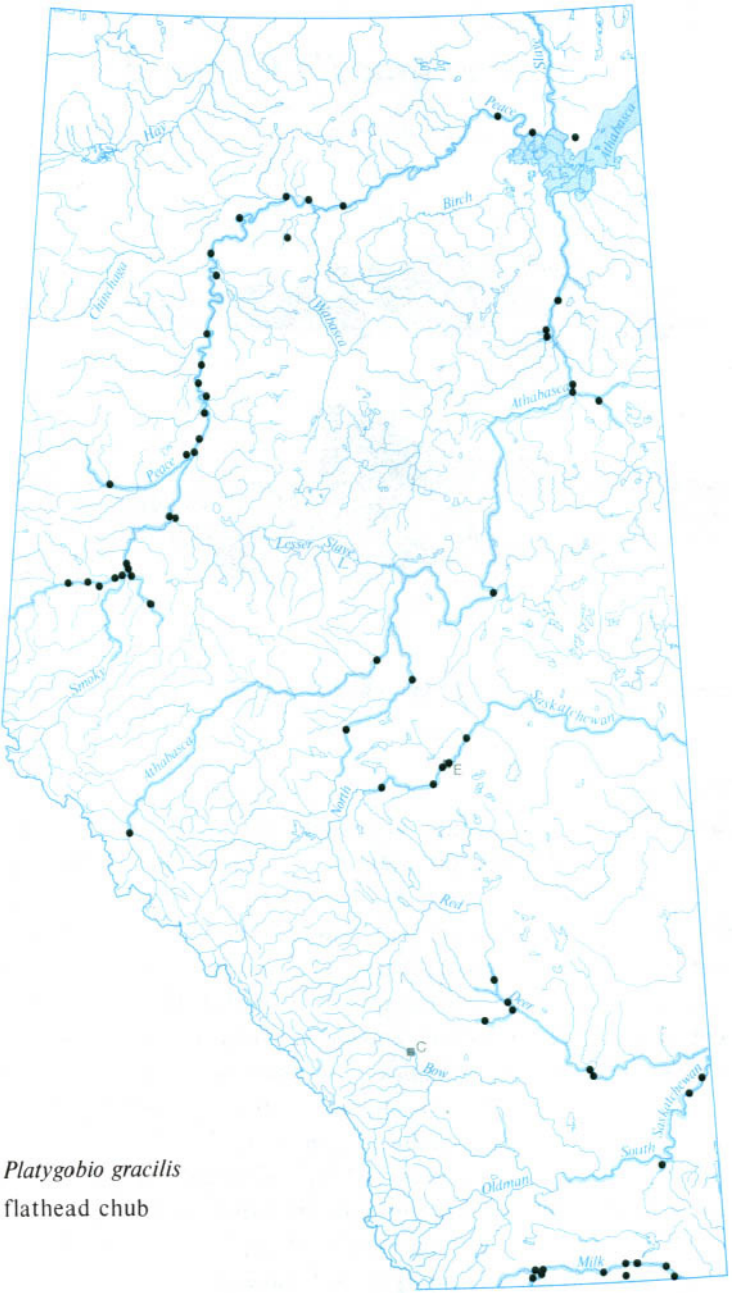
Description

Color: Pale brownish dorsally, silvery laterally. Young with faint blackish lateral band fading out anteriorly. Peritoneum silvery with no black mottling.

Body: Slightly compressed. Head broad and flattened dorsally, space between eyes about 2 to 2 1/2 times eye diameter; eyes small; mouth large (extending to front margin of eye and distinctly longer than eye diameter), subterminal, and slightly oblique; barbels conspicuous and placed at end of upper jaw. Isthmus moderate, less than 1/2 width of head. Origin of dorsal fin above or slightly in front of insertion of pelvics. Lateral line complete and slightly decurved. Dorsal, anal, and pectoral fins falcate (sickle-shaped). Caudal fin deeply forked. Lateral-line scales 45-59; scales above lateral line about 7 or 8 and around caudal peduncle about 16-18; dorsal and anal fin rays 8; gillrakers about 4-7; pharyngeal teeth 2,4-4,2.

Breeding males with minute tubercles on top of head and on the fins.

Size: Maximum length about 37 cm.



Map 12.11 Distribution of flathead chub in Alberta.

Alberta

All but one of 110 specimens from throughout Alberta have 8 rays in each of the dorsal and anal fins. Vertebral number in the same 110 specimens is 42-47, with the majority 44 or 45. The Peace River specimens have more vertebrae (21 specimens with 44-46 vertebrae) than Milk River specimens (28 with 42-45 vertebrae).

Specimens in the Peace-Athabasca Delta are exceptionally large and the Canadian record (and perhaps world record) of 37 cm total length (510 g) was obtained from the delta in Wood Buffalo National Park (Kristensen 1980). Specimens up to 25 cm fork length have been taken at Edmonton.

Distribution

● Northwestern British Columbia to Manitoba and northward in the Mackenzie system and southward to New Mexico and Louisiana (in the Mississippi River only).

■ Widespread in Alberta in Slave, Peace, Athabasca, North Saskatchewan, Red Deer, South Saskatchewan, Oldman, and Milk river drainages (see Map 12.11).

Biology

In Alberta flathead chub occur primarily in large rivers with high seasonal silt loads. They are often very abundant. They frequent backwaters or river margins and are sometimes caught by fishermen on natural baits. Their diet is made up of terrestrial and aquatic insects and occasionally fish. Spawning probably occurs in July and early August. In the Peace River, Bishop (1975a) reports that they become sexually mature by age 4 (about 18 cm in length) and live as long as 10 years.

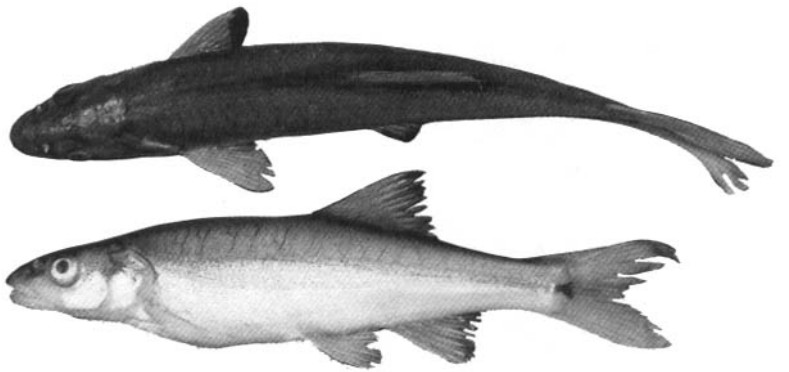
Historical Note

Sir John Richardson first described the flathead chub in 1836 from Carleton House, Saskatchewan River, as *Cyprinus (Leuciscus) gracilis*. Over the last 20 or so years most workers placed this species and 15 others in the genus *Hybopsis* . However, the genus *Hybopsis* as recognized in Robins et al. (1980) is now regarded as artificial and most current workers have resurrected *Platygobio* for the flathead chub, where we placed it in the 1970 edition of this book. Flathead chub were first noted in Alberta by Eigenmann (1895) at Medicine Hat. Preble (1908) found it

abundant in the Athabasca River from Athabasca northward while Whitehouse (1919) reported it to be common in the vicinity of Red Deer. Bajkov (1927) recorded it in the Athabasca River in Jasper National Park.

12.12 Northern Squawfish *Ptychocheilus oregonensis* (Richardson)

[*Ptycho cheilus:* fold lip (skin of mouth behind jaws is folded); *oregonensis:* of Oregon]



Northern squawfish juveniles, 89 mm standard length, from Dunvegan, Peace River.

Description

Color: Pale brownish dorsally, silvery laterally. Belly often yellowish. Young with faint blackish lateral band fading out anteriorly. Distinct black spot at base of caudal fin in young and juveniles. Peritoneum silvery with few black spots. Breeding males have orangish fins and a white line below the lateral line. Small nuptial tubercles may occur in the head, back, and paired fins.

Body: Slightly compressed. Head long, conical, and slightly rounded dorsally, space between eyes about 2 times eye diameter; eyes moderate; mouth large (extending past front margin of eye and much longer than eye diameter except in small fish), terminal to very slightly subterminal, and slightly oblique; barbels absent. Isthmus narrow, about 1/4 width of head. Origin of dorsal fin slightly behind insertion of pelvics. Lateral line complete and decurved. Caudal fin deeply forked. Lateral-line scales 65-77; dorsal and anal fin rays 8-10, in Alberta usually 9 and 8, respectively; pharyngeal teeth usually 2,5-4,2.

Size: Maximum length 63 cm. This is the largest species of the family Cyprinidae that is native to Alberta.

Map 12.12 Distribution of northern squawfish in Alberta.

Alberta

Meristic counts have been obtained from three specimens from the Peace River. Scales along lateral line 65-67; above lateral line 15 or 16; around caudal peduncle 25-27. Gillrakers on first gill arch: upper arch 2; lower arch 7; total 9. The vertebral number in 11 specimens: 45-47; most have 46 or 47.

The largest specimen reported in Alberta was 43 1/2 cm fork length. It was caught by F. Somerville at the town of Peace River.

Distribution

● In Pacific slope drainages of North America from British Columbia to Oregon; east of the Continental divide only in the Peace River system of British Columbia and Alberta. Widespread in British Columbia in Fraser and Columbia river drainages, generally absent or rare in coastal areas.
■ Restricted in Alberta to the Peace River system, downstream to the town of Peace River and possibly to the Cadotte River (see Map 12.12). They are relatively rare in Alberta, unlike in many British Columbian waters.

Biology

Northern squawfish are primarily lake inhabitants but are found only in the Peace River in Alberta. The young feed on insects and plankton while juveniles and adults feed extensively on fish. Spawning occurs from May to July over gravel in shallow waters. Sexual maturity is probably reached in the sixth year and the life span of an individual may be as long as 20 years. In British Columbia, hybrids are known that are the result of crossing between northern squawfish and chiselmouth, redside shiner, and peamouth.

One of the concerns over any water diversion scheme between the Peace River drainage and the North Saskatchewan River drainage is that it might allow the piscivorous squawfish (along with the redside shiner) to gain access to prairie drainages. Squawfish could have a negative impact in sport and commercial fishes in areas where it might spread.

Historical Note

Sir John Richardson first described northern squawfish in 1836 from the Columbia River as *Cyprinus* (*Leuciscus*) *oregonensis*. The species was first recognized in Alberta by R.B. Miller and M.J. Paetz with the capture of one specimen at Dunvegan, Peace River on 15 August 1956.

12.13 Longnose Dace *Rhinichthys cataractae* (Valenciennes)

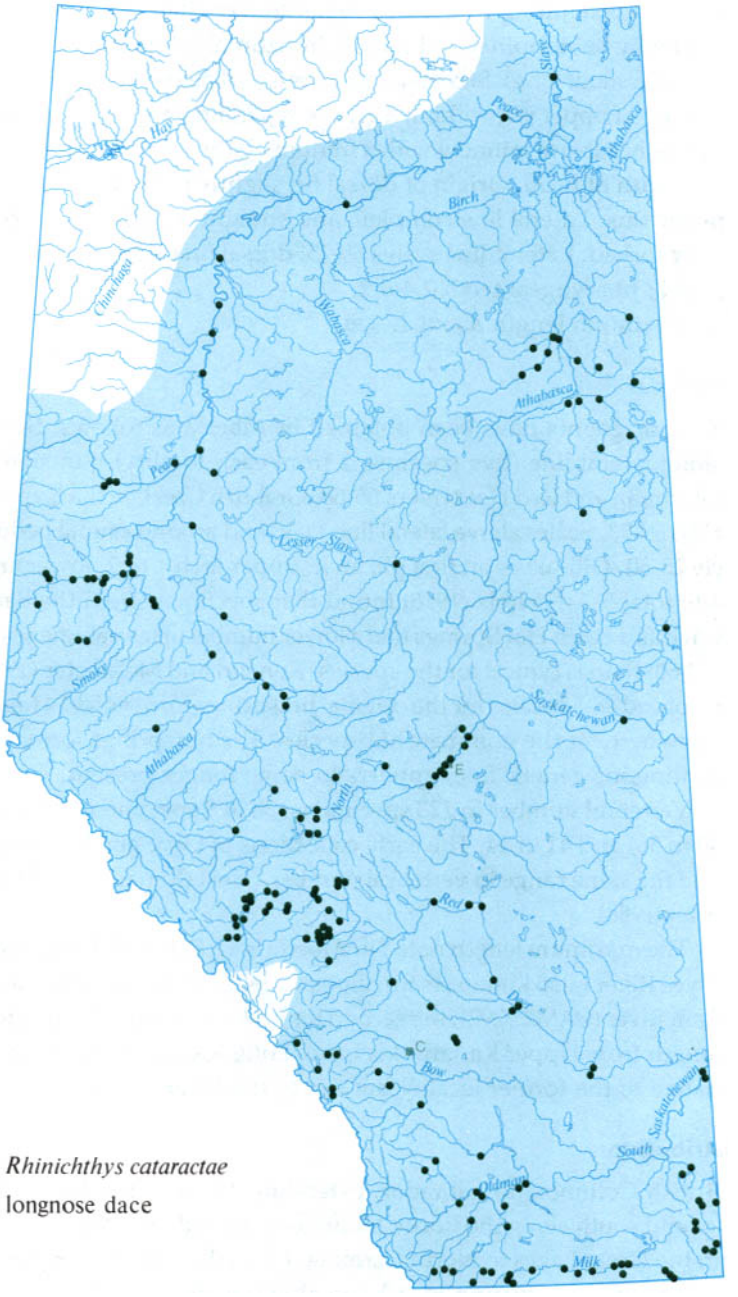
[*Rhin ichthys:* snout fish (referring to long snout); *cataractae:* of the cataract (Niagara waterfall)]

Longnose dace from Ghostpine Creek, Red Deer River drainage, March 1989. Photo courtesy of W.E. Roberts.

Description

Color: Darkish dorsally, darkish to silvery laterally with mottling often present. Young with a distinct blackish lateral band from gill cover to tail and on snout but not extending across upper lip; band usually faint or absent in adults. Peritoneum somewhat silvery with much black mottling. Reddish-orange tinge at the base of the pectoral, pelvic, and anal fins and on the upper lip or at corner of mouth and lower cheeks in breeding individuals. Usually the reddish-orange coloration is more intense in males than in females, where it can be absent. However, some female museum specimens from the Cypress Hills and Red Deer River tributaries seem to have more intense coloration than some males (see Biology for further comments on color of breeding adults).

Body: Rounded in cross section. Head conical and slightly rounded dorsally, space between eyes about 2 1/2 times eye diameter; eyes small and placed entirely on upper half of head. Mouth moderate in



Map 12.13 Distribution of longnose dace in Alberta.

size (not extending to eye but much longer than eye diameter), markedly subterminal and almost horizontal (almost sucker-like, with the snout long). Barbels conspicuous and placed at end of upper jaw; tip of upper jaw without a groove separating it from tip of snout (the only Alberta minnow with a frenum). Isthmus wide, more than 1/2 width of head. Origin of dorsal fin slightly behind insertion of pelvic fins. Lateral line complete and straight. Caudal fin moderately forked. Lateral-line scales 55-75; dorsal fin rays 8 and anal fin rays 7; pharyngeal teeth 2,4-4,2.

Size: Maximum length about 17 cm.

Alberta

Meristic counts have been obtained in Alberta as follows. Scales along lateral line (five specimens from each locality): junction of Blindman and Red Deer rivers 65-68; Graburn Creek in the Cypress Hills 59-73. Scales above lateral line 11-13 and around caudal peduncle 25-30. Gillrakers on first gill arch: upper arch 1 or 2; lower arch 4-6; total 5-7. Nichols (1916) found that specimens from the Banff Cave and Basin Hot Springs had a lower number of lateral-line scales (50-60) than is typical for the species. Renaud and McAllister (1988) recorded 48-58 scales for the original hotsprings form vs 58-74 found elsewhere for the nominate subspecies. The hotsprings form, as a continuous genetic line, appears to be no longer present.

Vertebral number in 123 specimens: 38 in 9 specimens, 39 in 42, 40 in 58, and 41 in 14. The early collections of Cave and Basin dace had the same range in vertebral number, 38-41 (Renaud and McAllister 1988).

The maximum length noted in Alberta is 12.6 cm fork length from Joyce River (also known as Smallpox Creek), tributary to the North Ram River (UAMZ 5292); the second longest specimen is 11.0 cm fork length from Upper Kananaskis Lake. Longnose dace are probably native to the former locality but not to the latter.

Distribution

● British Columbia to Labrador, extending north in the Mackenzie River and south along the Rocky Mountains to northern Mexico; south from the Great Lakes to North Carolina. It has the widest distribution of any minnow occurring in Alberta although the lake chub comes a close second.

■ Widespread in Alberta in Peace, Athabasca, North Saskatchewan, Battle, Red Deer, Bow, Oldman, South Saskatchewan, and Milk river drainages (see Map 12.13).

Biology

Longnose dace occur in lakes, rivers, and small creeks, often in association with lake chub. It is one of our commonest non-salmonids occurring in mountain lakes and streams. Individuals are more benthic (bottom-living) than any of our other minnows and therefore they can occur in fast flowing streams. They feed primarily on aquatic insect larvae (e.g., dipterans). Unlike the pattern in other minnows so far studied, they feed primarily at night, perhaps as a means of reducing predation, at least in foothills streams studied near Calgary (Culp 1989; Beers and Culp 1990). Spawning occurs from May to early August. They spawn in both streams and lakes, usually over gravel. A maximum age of 4 years has been reported for males and 5 years for females.

Dr. J.H. Gee of the University of Manitoba, Winnipeg, has shown the remarkable degree to which longnose dace can adjust the volume of their swim bladder and thereby alter their buoyancy in response to changes in water velocity. In currents (or in strong wave action) these fish tend to reduce the volume of the swim bladder and so become negatively buoyant. This allows them to remain on the bottom with minimum energy expenditure, out of the full force of the current. Newly emerged fry must come to the surface to gulp air to initially fill their swim bladder.

Bartnik (1972) and Renaud and McAllister (1988) discuss differences between two widespread subspecies, both of which probably occur in Alberta. The eastslope longnose dace occurs east of the Continental Divide; the males have bright crimson red patches at the corner of the mouth, cheeks, and bases of the paired fins and anal fin (the female may have a faint pink in the same areas). Eastslope longnose dace spawn in the daytime. The westslope longnose dace occurs in British Columbia but probably also extends east of the Continental Divide; the coloration in males is faint or absent (absent in females). This subspecies spawns at night.

Longnose dace hybridize with lake chub in Upper and Lower Kananaskis lakes (Nelson 1966, 1973a; Butcher 1979, 1980) and are known to hybridize with redside shiners in British Columbia.

Historical Note

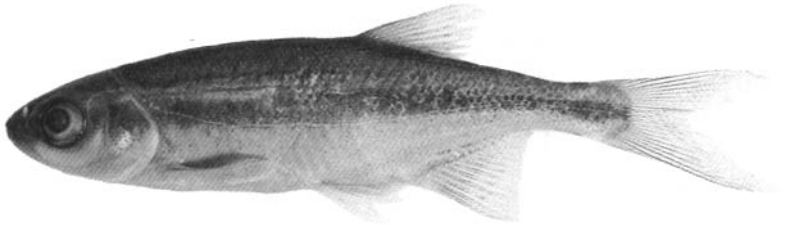
A. Valenciennes (in Cuvier and Valenciennes) first described longnose dace in 1842 from Niagara Falls as *Gobio cataractae*. It was first noted in Alberta as *Rhinichthys dulcis* by Eigenmann (1895) at Medicine Hat, Calgary, and at Banff in the Bow River and in hot sulphur springs.

Specimens collected at the Cave and Basin Hot Springs in 1915 were described as a new subspecies, *Rhinichthys cataractae smithi*, by Nichols (1916). R.B. Miller's notes indicate that he had in his care a collection made from the same site July 27, 1924, under the name *Agosia nubilus*. The morphological form once in Cave and Basin is apparently no longer present (Lanteigne 1988; Renaud and McAllister 1988). The loss of this form is thought to be due to hybridization with *R. c. cataractae* from the Bow River, detrimental effects from the introduced mosquitofish, and changes in the flow of the springs. To us, the validity of the subspecies is still open to question since the observed morphological differences could have been the result of the eggs being reared in warm water. Longnose dace from the Bow River still have access to the marsh area and individuals thought to be of this origin are occasionally seen. The water level in the marsh is now low due to a break in a beaver dam and beavers have left the site, at least temporarily.

Bajkov (1927) identified one of the three species of cyprinid that he obtained from Jasper National Park as *Agosia nubila* (Girard) (dusky minnow). It was reported from Annette, Edith, Pyramid, and Patricia lakes, some creeks, and the Athabasca River. This species, also noted by Bajkov to occur in British Columbia, Washington, Idaho, and Oregon, is a synonym of *Rhinichthys osculus* (speckled dace). It seems unlikely that this species, nor the related *R. falcatus* (leopard dace) which also occurs in British Columbia, occurred in the Jasper area. It is questionable that Bajkov's material represents *R. cataractae* as accepted in Paetz and Nelson (1970), but we cannot be positive what it does represent. Bajkov gives a source of synonyms as "Jordan and Evermann"; this publication and Bajkov note *A. nubila* to have an inferior mouth (true for *R. cataractae*), but the generic description in "Jordan and Evermann" states that the premaxillaries are protractile (not true for *R. cataractae*). The only cyprinid reported from Patricia Lake by Anderson (1970) is *Couesius plumbeus*, a species having the eye diameter greater than the snout length as noted by Bajkov for his material (and unlike *R. cataractae*); however, *C. plumbeus* has a terminal mouth.

12.14 Redside Shiner *Richardsonius balteatus* (Richardson)

[*Richardsonius:* after Sir John Richardson; *balteatus:* girdled]



Redside shiner, from Redwillow River, Wapiti River drainage, 27 Aug. 1966.

Description

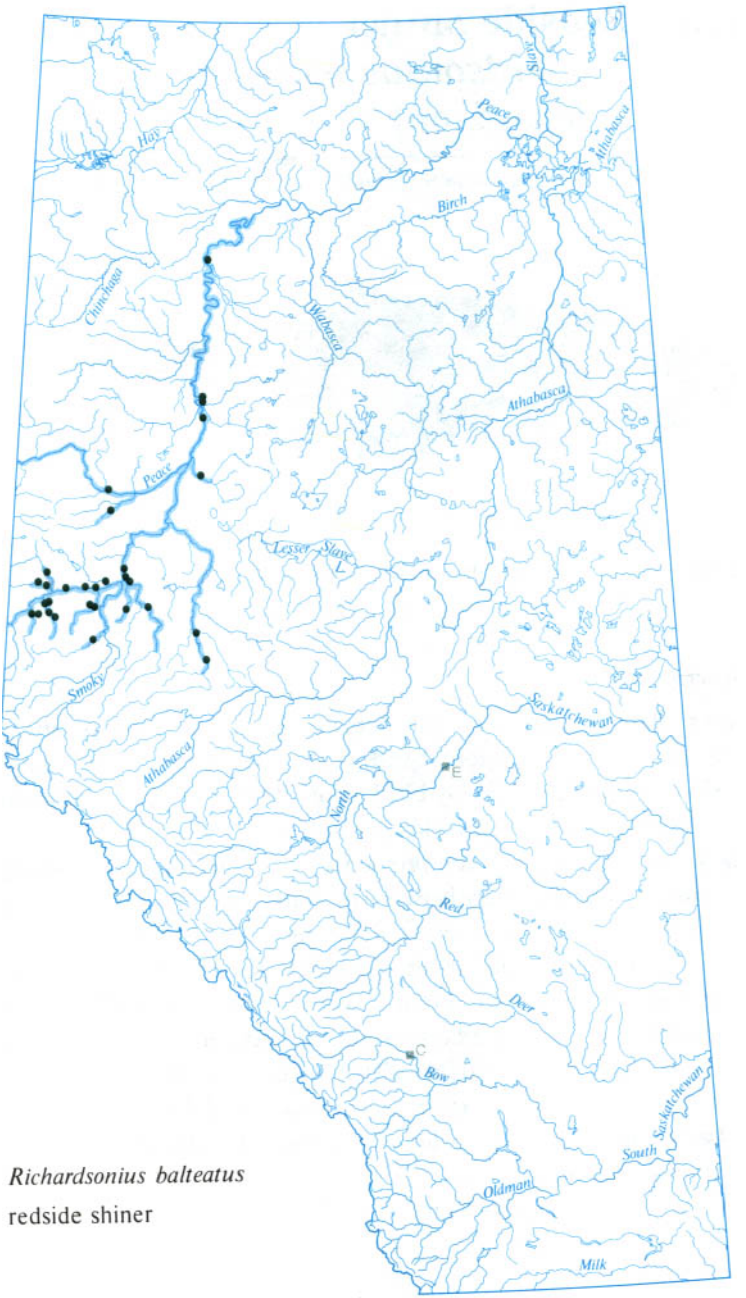
Color: Dark olive or brownish dorsally, silvery laterally. Young and adults with a dark lateral band, fading out anteriorly. Peritoneum silvery with few to many black spots. Males brilliant at spawning time with yellow and vivid crimson on sides and belly.

Body: Deep and strongly compressed. Head short, conical, and strongly rounded dorsally, space between eyes about 1 1/2 times eye diameter; eyes large; mouth moderate (extending or almost extending to front margin of eye and about equal in length to eye diameter), terminal or with lower lip extending forward slightly beyond upper lip, moderately oblique; barbels absent. Isthmus narrow, about 1/4 width of head. Origin of dorsal fin well behind insertion of pelvic fins. Lateral line complete and strongly decurved. Caudal fin deeply forked. Lateral-line scales 52-67; dorsal fin rays 8-11 and anal fin rays 10-22; pharyngeal teeth 2,5-4,2.

Size: Maximum length 18 cm.

Alberta

Meristic counts have been obtained from 15 specimens from the Smoky River. Scales along lateral line 52-58; above lateral line 11-13; and around caudal peduncle 18-20. Gillrakers on the first gill arch:



Map 12.14 Distribution of redside shiner in Alberta.

	Number of anal fin rays				
	13	14	15	16	17
Smoky River	15	1	1	6	3
Beaverlodge River	-	1	2	3	-
Peace River, Dunvegan	-	-	-	2	2
Economy Creek	1	1	2	1	-
Pinto Creek	-	-	1	3	1
Simonette River	1	1	7	4	1

upper arch 1 or 2; lower arch 6 or 7; total 7-9. Anal fin ray frequency was determined in specimens from six localities:

Vertebral number in 26 specimens from the Smoky River: 41 in 4 specimens, 42 in 15, and 43 in 7.

Maximum length observed for Alberta is 10.8 cm fork length from Pinto Creek in the Wapiti River drainage.

Distribution

● British Columbia to Oregon, eastward to Utah, and in the Peace River system of Alberta. Widespread in eastern British Columbia in Fraser and Columbia drainages and very common in Williston Reservoir and many lakes in Peace River drainage.

■ Native populations are restricted in Alberta to the Peace River system. Known from Big Mountain, Pinto, and Economy creeks, Wapiti, Smoky, Little Smoky, Simonette, and Beaverlodge rivers, and Peace River north to the Cadotte River and near Carcajou (see Map 12.14). An introduced population exists in Lee Lake in southwestern Alberta (Oldman River drainage, south of the Crowsnest Pass Highway and east of Bellevue). It was discovered in 1986 by Fish and Wildlife workers and was reported to be abundant in 1987 and 1988. Lee Lake is effectively landlocked.

Biology

In Alberta, natural populations of redside shiners are known only from rivers while in British Columbia they commonly occur in both lakes and streams. In the Peace River drainage of Alberta they are often very abundant. They feed on crustaceans and aquatic and terrestrial insects. Spawning occurs from June to July. Individuals probably live

as long as 5 years. In British Columbia, redside shiners hybridize with longnose dace, northern squawfish, and peamouth.

Redside shiners are known to have an adverse effect on rainbow trout in some lakes in British Columbia (although large rainbow trout do feed on small redside shiners). There is thus concern that this minnow may become further established in prairie drainages through introduction by water diversion schemes involving the Peace River system or through use as a bait fish. The illegally introduced population in Lee Lake poses a threat and increases the chances of this species becoming established in the main part of the South Saskatchewan River system and downstream. An attempt to eradicate the Lee Lake population was made by government biologists in 1990.

Historical Note

Sir John Richardson first described the redside shiner in 1836 from the Columbia River as *Cyprinus (Abramis) balteatus*. It was placed in the genus *Gila* by some earlier workers. It was first taken in Alberta by R.B. Miller and R.C. Thomas on 16 August 1954 in the Wapiti River and Big Mountain Creek.

13 Sucker family—Catostomidae

MEMBERS OF THE sucker family are found in North America, eastern Siberia, and China. Their greatest diversity occurs in the United States. This freshwater family contains 61 species. Some 18 species occur in Canada with seven species in Alberta (five in British Columbia; two in the Northwest Territories; and seven in Saskatchewan). Fossils of the Eocene-Oligocene age sucker, *Amyzon*, occur in British Columbia. The sucker and minnow families are similar in several features and are fairly closely related; both are placed in the order Cypriniformes.

Of the seven species of suckers in Alberta, the longnose and white suckers are the most common and widespread, occurring in all major drainages. Three species occur in the Arctic drainage while six occur in the Hudson Bay drainage. There is a marked tendency for the species with small scales to occur farther upstream, at higher elevations, than the large-scaled species. Thus, the longnose and mountain suckers with the smallest scales of our seven species are our commonest species in or near the Rocky Mountains while the quillback and redhorse suckers, with the largest scales, are more restricted to relatively slow-moving rivers well downstream from the Rocky Mountains. The significance of this relationship is unknown, but one may wonder if there is some advantage in swimming for small-scaled fish in cold mountain streams.

In some lakes, suckers may reach relatively large sizes, often exceeding 45 cm in length. They generally feed on small animals (insects, snails, worms, etc.) and algae on the bottom of lakes and rivers; their protrusible subterminal mouth is well adapted for such substrate feeding (newly hatched suckers have a terminal mouth). Spawning occurs

in the spring and early summer. There is no care of the eggs or the young by the adults.

Suckers lack teeth on the jaws but possess 16 or more comb-like pharyngeal teeth placed in one row (see discussion on the minnow family for comments on dissecting out the pharyngeal arch). The upper jaw margin is usually formed by both the premaxillaries and the maxillaries. Suckers have 3 branchiostegal rays (1 on the epihyal bone and 2 on the ceratohyal bone of the hyoid arch) and 30-50 vertebrae. All suckers have a broad isthmus, usually more than 1/3 width of head. The origin of the dorsal fin is in front of the pelvic fin insertion. Most Alberta species have 7 anal fin rays, but *Carpiodes* often has 8 rays. Most have 16 branched caudal fin rays. The intestine usually exceeds 2 times the standard length. There are no pyloric caeca and the stomach is not externally differentiated from the rest of the alimentary canal. Females, on the average, are longer than males at any given age in mature individuals; however, considerable overlap in length occurs. Before spawning time adult males usually develop conspicuous tubercles on the anal fin and lower lobe of the caudal fin; these tubercles may last several months. However, the sex of mature individuals may be determined with considerable reliability in any season by examining the pelvic fins (as shown in Fig. 13a). In males, the 3rd ray is shorter than the 7th (it is rarely about equal to the 7th ray) while in females (and immature individuals) the 3rd ray is longer than the 7th (the profile of the fin is considerably different as a result) (unpublished data of J.S. Nelson). This sexual dimorphism is not apparent in Alberta minnows although they are fairly closely related to suckers.

Suckers are a much maligned fish. They are sometimes referred to as rough, coarse, or trash fish—terms just as inappropriate for these fish as they would be if applied to any of the nongame birds such as chickadees, grosbeaks, killdeer, or nutcrackers. Usually occurring in large numbers, suckers, although sometimes marketed as "mullet," are under-utilized as a commercial and a sports fish; some species may put up a good fight on light tackle and can be tasty when smoked or baked. They are important in the diet in many other fish. They are a good fish to watch, whether the observer is a SCUBA diver or on shore seeing them spawn in the springtime in a clear stream. There is considerable controversy on whether or not suckers adversely affect trout. One study in Paine Lake in southwestern Alberta found much overlap in the diet of suckers and trout (Barton and Bidgood 1980), but this does not demonstrate that competition is occurring; on the other hand, Roberts

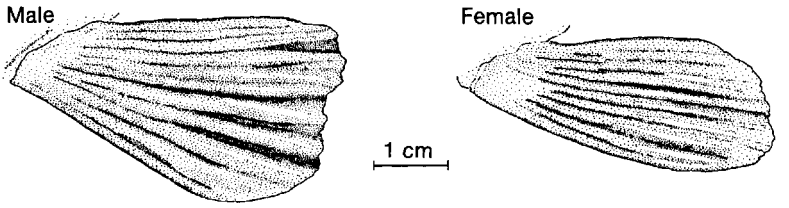


Fig. 13a Side view of left pelvic fin in a male (which shows the modified form) and female white sucker. Anterior margin of fin to lower left.

(1975b) provides evidence that they are an important prey fish for walleye and northern pike in Cold Lake. The exact net balance of benefits or detrimental effects probably differs between localities. In addition, we are not about to perpetuate the view that the value of suckers be measured solely in terms of their interaction with trout.

Bruner (1991) gives a bibliography to the species of this family. Information on their parasites is given in Arai and Kussat (1967), Margolis and Arthur (1979), and Margolis and Kabata (1984-1989).

Key to the 7 Species

Use the following key and Fig. 13b to identify species in the sucker family. For an explanation of how to use the key, see Section 7.2.

1A Scales relatively large, 35-48 along lateral line, fewer than 8 above lateral line; lips plicate..... GO TO 2A AND 2B.

1B Scales relatively small, 55-115 along lateral line, more than 8 above lateral line; lips papillose..... GO TO 4A AND 4B.

(FROM 1A)

2A Dorsal fin rays 22-32; dorsal fin base long, more than 1/4 of standard length; lateral-line scales usually fewer than 40..... .....**Quillback—*Carpiodes cyprinus*.** SEE SECTION 13.1.

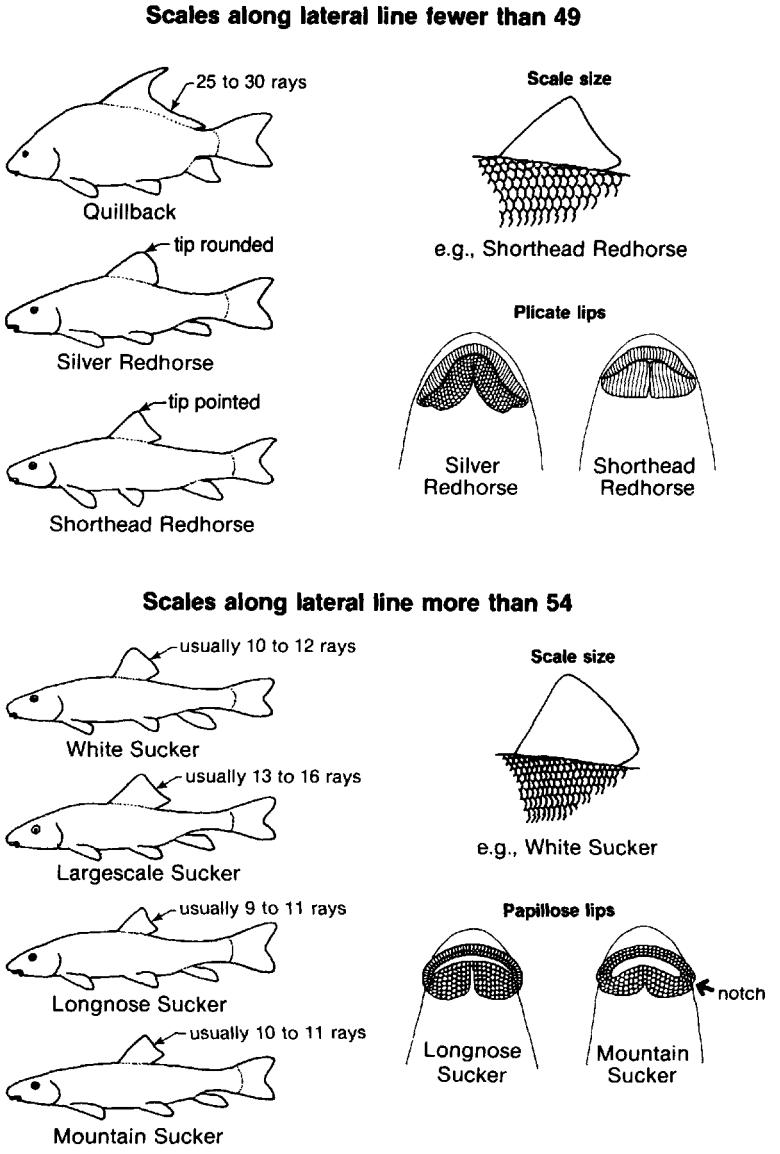


Fig.13b Outline drawings to supplement the Key to the suckers of Alberta.

2B Dorsal fin rays 11-18; dorsal fin base short, less than 1/4 of standard length; lateral-line scales usually more than 39..... .....GO TO 3A AND 3B.

(FROM 2B)

3A Posterior margin of lower lip forms an approximate right-angle at midline, not a straight line; dorsal fin rounded at front tip and with rounded outer margin; body scales without dark spots at base; caudal fin olive or slate-colored in life..... .....**Silver redhorse—*Moxostoma anisurum*.** SEE SECTION 13.6.

3B Posterior margin of lower lip forms a straight line; dorsal fin pointed at front tip and with a falcate (sickle-shaped) outer margin; body scales on upper side each with a dark spot at base; caudal fin reddish in life..... .....**Shorthead redhorse—*Moxostoma macrolepidotum*.** SEE SECTION 13.7.

(FROM 1B)

4A Scales around caudal peduncle more than 21, above lateral line usually more than 15, and along lateral line usually more than 79 (occasionally as few as 70); dorsal fin usually with 9 to 11 rays (rarely 12); peritoneum blackish or black...GO TO 5A AND 5B.

4B Scales around caudal peduncle fewer than 21, above lateral line usually fewer than 15, and along lateral line usually fewer than 80 (occasionally up to 85); dorsal fin usually with 11 to 16 rays (rarely 10 or 17); peritoneum silvery or dusky..... .....GO TO 6A AND 6B.

(FROM 4A)

5A Large notch at each corner of mouth between upper and lower lips; cleft in midline of lower lip shallow, with 3 or more rows of papillae crossing in front; edge of lower jaw with a sharp-edged cartilaginous sheath; lateral-line scales usually fewer than 91; small fleshy struts connecting inner rays of pelvic fins to body. Note: the distinct notch at the corner of the mouth

and the shallow cleft in the lower lip are easily seen, under magnification, in specimens as small as 3 cm standard length... ..... **Mountain sucker—*Catostomus platyrhynchus*.**
SEE SECTION 13.5.

5B No distinct notch between upper and lower lips; cleft in midline of lower lip deep, usually no papillae crossing cleft; lower jaw without cartilaginous sheath; lateral-line scales more than 90; no fleshy struts connecting inner rays of pelvic fins to body ..... **Longnose sucker—*Catostomus catostomus*.**
SEE SECTION 13.2.

(FROM 4B)

6A Dorsal fin with 11 to 12 rays (rarely 10 or 13); scales above lateral line 9 to 11; ratio of distance between front of dorsal fin and front of pelvic fin to depth of caudal peduncle (narrowest area between dorsal fin and tail) 1.9 to 2.5 (accurate only in specimens between 5 and 24 cm standard length)..... ..... **White sucker—*Catostomus commersoni*.**
SEE SECTION 13.3.

6B Dorsal fin with 13 to 16 rays (rarely 12 or 17); scales above lateral line 11 to 15; ratio of distance between front of dorsal fin and front of pelvic fin to depth of caudal peduncle 2.6 to 3.4.... ..... **Largescale sucker—*Catostomus macrocheilus*.**
SEE SECTION 13.4.

13.1 Quillback *Carpiodes cyprinus* (Lesueur)

[*Carpiodes:* carp-like; *cyprinus:* carp]

Quillback, from South Saskatchewan River near Medicine Hat. Photo courtesy of G. Clements.

Description

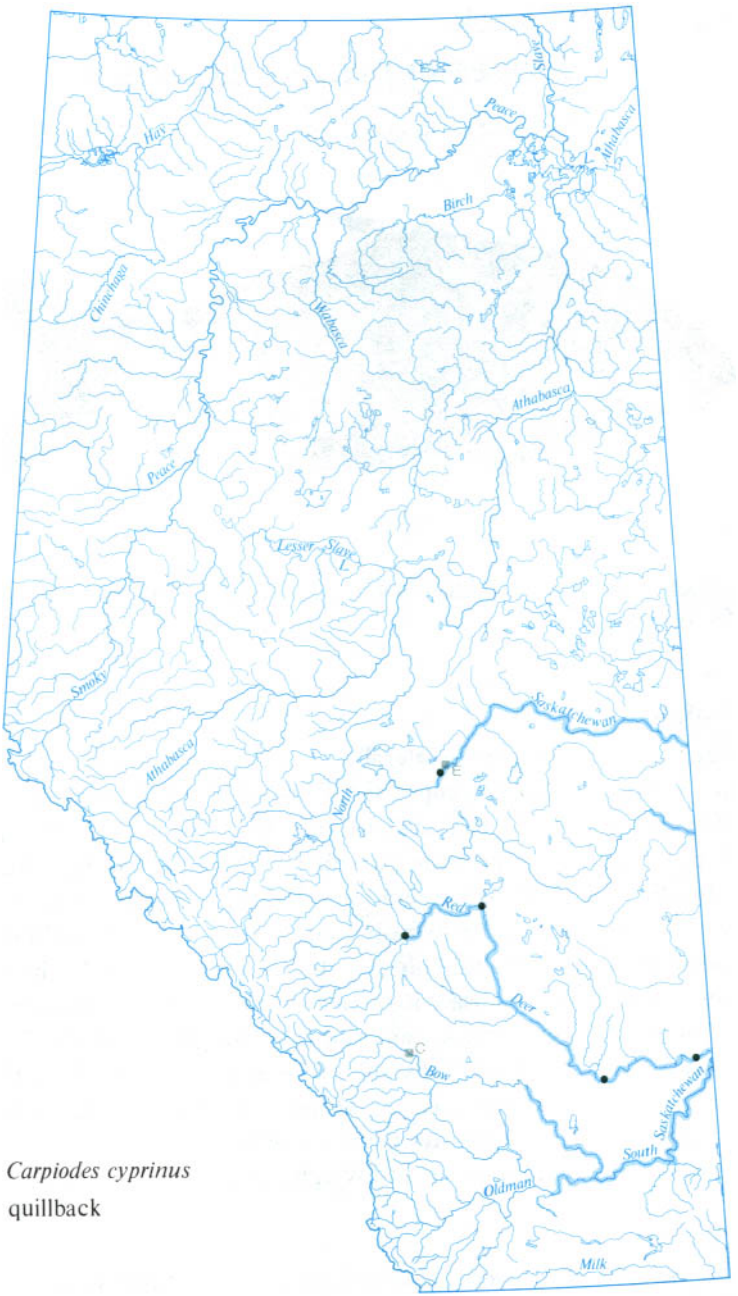
Color: Tan dorsally, silvery laterally.

Body: Deep and strongly compressed. Head subtriangular and strongly rounded dorsally. Mouth small, horizontal, and slightly subterminal. Lips thin and weakly plicate. No small knob at tip of lower jaw (unlike other members of the genus). Anterior fontanelle (an opening through the skull bones between nostrils and eyes on midline of head) present throughout life (as is the posterior fontanelle the anterior fontanelle—is absent in other Alberta suckers). Anterior part of dorsal fin highly falcate, anterior rays elongate; dorsal fin base very long, more than 1/4 of standard length. Swim bladder with 2 chambers. Lateral-line scales 34-42 (usually fewer than 40); dorsal fin rays, 22-32; anal fin rays usually 7 or 8.

Size: Maximum length 66 cm and weight 4.0-5.4 kg.

Alberta

All meristic counts were obtained from Red Deer River specimens. The dorsal fin ray frequency in 83 specimens is as follows (there are, in addition, 2-4 rudimentary rays):



Map 13.1 Distribution of quillback in Alberta.

Number of dorsal fin rays							
25	26	27	28	29	30	31	32
1	3	13	26	22	12	5	1

Anal fin ray number in 85 specimens: 6 in 2 specimens, 7 in 42, 8 in 35, and 9 in 6. In addition, there are 1-3 rudimentary rays in the anal fin. Eleven specimens have 34-39 lateral-line scales. Vertebral number in 51 specimens: 39 in 22 specimens, 40 in 27, and 41 in 2.

Maximum length known for Alberta is 50.8 cm fork length, angled from the Oldman River in 1980. This specimen was originally reported to be a goldeye but was reidentified as a quillback from a photograph (brought to our attention by W.E. Roberts—we normally consider it unacceptable to base records of fish on photographs; this photograph was the basis for once recognizing the record-size goldeye!). The largest verified records for quillback in Alberta are 44 cm, from the North Saskatchewan River near Edmonton (UAMZ 3535), and 43 cm, obtained from the Red Deer River east of Red Deer near Nevis in 1968 (UAMZ 2038). Larger specimens undoubtedly occur in the Red Deer River, but we lack measurements for them.

Distribution

● Alberta to southern Quebec and eastern Missouri to Virginia.

■ Known from central and southern Alberta from the North Saskatchewan, Battle, Red Deer, lower Bow, lower Oldman, and South Saskatchewan rivers (see Map 13.1).

Biology

Over its range the quillback occurs in lakes and large rivers (both clear and turbid). In Alberta it has been recorded from sluggish and usually turbid rivers but not from lakes. Individuals are sometimes in the mouths of smaller tributaries of the North Saskatchewan (i.e., Sturgeon River) and lower Red Deer rivers. They are bottom feeders and individuals live up to at least 12 years. Nothing is known of their spawning habits in Alberta. Elsewhere they are known to ascend creeks in the spring and spawn from May to July.

Historical Note

C.A. Lesueur first described the quillback in 1817 from tributaries of Chesapeake Bay as *Catostomus cyprinus*. It is the type species for the genus *Carpiodes*. The quillback was noted from Alberta by Eigenmann (1895) from the South Saskatchewan River at Medicine Hat as *Carpiodes velifer*.

13.2 Longnose Sucker *Catostomus catostomus* (Forster)

[*Cato stomus:* inferior mouth]

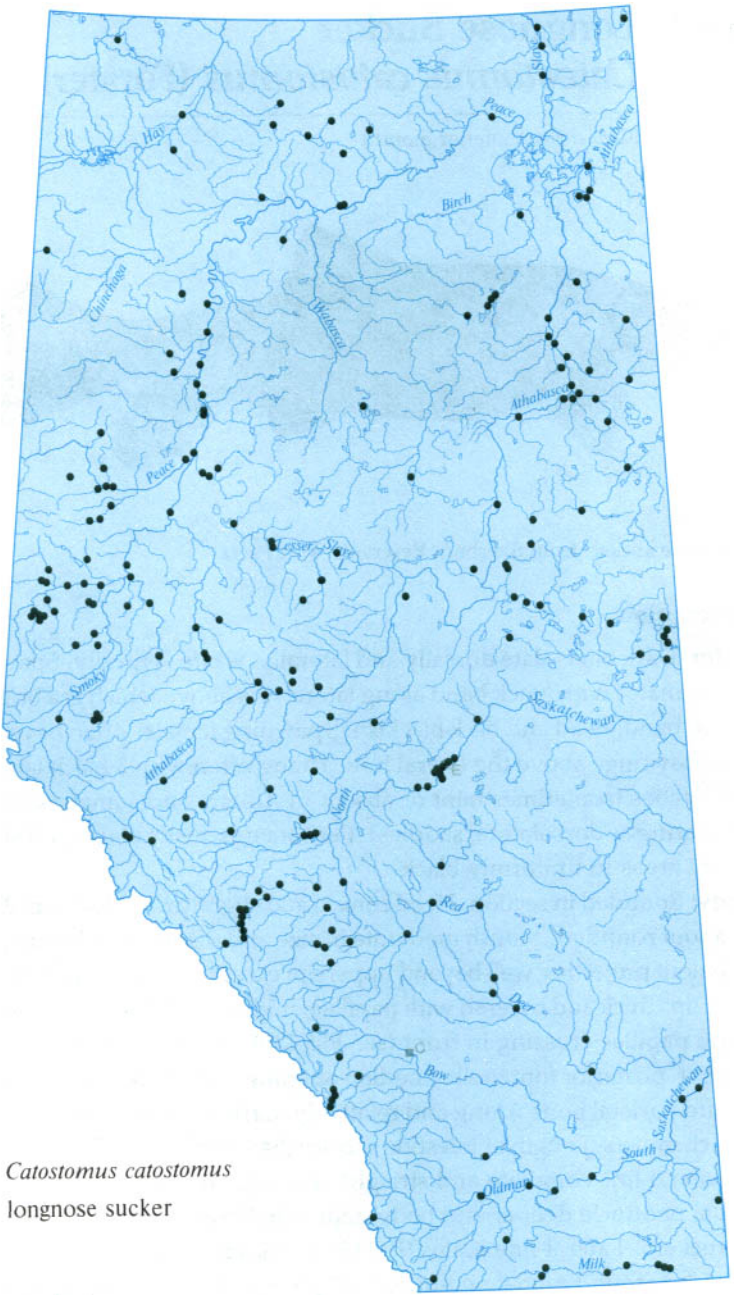
Longnose sucker, from Sherburn Reservoir. M.J. Paetz.

Description

Color: Dark olive-slate dorsally and laterally, white ventrally. Spawning males with black band along lateral line above which is a bright red band; head and back blackish. Spawning females often develop a rosy tinge above the lateral line. Young often with 3 black lateral blotches (sometimes faint or absent in Alberta and sometimes appearing as dorsolateral saddles). Peritoneum dusky black with silvery areas to uniformly black.

Body: Rounded in section. Head conical and slightly rounded dorsally; snout rounded. Mouth moderate in size and distinctly subterminal (snout projecting well beyond upper lip, except in very young). Lower lips thick and covered with papillae; midline cleft deep, often with no papillae crossing in front (see Fig.13b). Anterior fontanelle absent, posterior fontanelle (median opening in skull between frontal and parietal bones) long and relatively narrow. Swim bladder with 2 chambers. Length of intestine shorter than 4 times standard length. Lateral line complete and straight. Young and juveniles with caudal peduncle deeper and body depth shallower than in largescale suckers. Lateral-line scales 91-115; scales above lateral line 16-21; scales around caudal peduncle 25-29; dorsal fin rays 9-11 (in Alberta most with 10).

Size: Maximum length 64 cm and weight 3.3 kg (from Great Slave Lake).



Map 13.2 Distribution of longnose sucker in Alberta.

Alberta

Gillrakers about 25-27. Vertebral number in eight specimens from Pierre Greys Lakes: 46-48.

Maximum length noted in Alberta is 52.1 cm fork length (1.8 kg) from Barrier Reservoir (Seghers 1988).

Distribution

● Eastern Siberia through Alaska and the Northwest Territories to New Brunswick and in the south from Idaho to New York.

■ Known throughout Alberta in Hay, Slave, Peace, Athabasca, Beaver, North Saskatchewan, Red Deer, Bow, Oldman, South Saskatchewan, and Milk river drainages (see Map 13.2).

Biology

The longnose sucker is found in rivers and lakes (most often in deep lakes). In Alberta they usually spawn from late May to early July. Spawning usually occurs in creeks but beach spawning is assumed to occur in many Alberta lakes that appear to lack suitable streams (as inlets or outlets) for spawning. Females of average size produce about 10,000-20,000 eggs during a spawning season. The young are frequently found in large schools along lake shores. Maturity is reached at about age 4 to 6. They are bottom feeders, consuming molluscs, crustaceans, immature insects, and worms. Longnose suckers are known to hybridize with the white and mountain suckers in the United States. The former hybrid occurs in Alberta in Upper Kananaskis Lake (Nelson 1973b) and Abraham Lake (Tebby 1974). Longnose suckers are frequently infected with the very large larvae of a tapeworm, *Ligula*, which occurs in the body cavity, and occasionally with "black spot" (*Neascus*), a trematode larvae, which encyst in the skin and stimulate the fish to deposit black pigment around them (see photograph of mountain sucker, 13.5).

Barton (1980) and Walton (1980) give information on their spawning, growth, and feeding behavior in southwestern Alberta.

Historical Note

J.R. Forster first described the longnose sucker in 1773 from streams about Hudson Bay as *Cyprinus catostomus*. It is the type species for the genus *Catostomus*. The longnose sucker was first noted from Alberta by Eigenmann (1895) at Medicine Hat, Calgary, and Banff as *Catostomus*

catostomus and additionally at Medicine Hat as *C. griseus*. It may be the longnose sucker that Vick (1913) refers to as being near the Vermilion Lakes at Banff (under the highly erroneous spelling for the white sucker, *Cutostonus Commersone*). Kendall (1924) noted it from Rivière Coupée, near Fort Chipewyan. Bajkov (1927) described it from four Jasper Park lakes (Annette, Patricia, Beauvert, and Pyramid) as a new subspecies, *C. catostomus lacustris*. Rawson and Elsey (1950) thought this distinction unwarranted. Although Bajkov's original reasons for recognizing the Jasper suckers as a separate subspecies seem illfounded, D.E. McAllister (personal communication) has found the number of gillrakers in Pyramid Lake longnose suckers to be lower than in other populations examined (20-23 vs 22-32). While this may not justify the recognition of a separate subspecies it would be worthwhile to examine other populations in the area and to also use techniques such as electrophoretic analysis to study the geographic variation. The difference in the gillraker counts in Pyramid Lake could possibly be due to local natural selection over a relatively short period of time or reflect a relatively long period of isolation of the population. Unfortunately, the interpretation of any difference in the suckers of these lakes is difficult because we cannot be sure what effect the illegal use of suckers from other areas as live bait had on the native population of suckers or the effect of various management schemes (Rawson and Elsey 1950; Anderson 1970). However, the fishes in Pyramid Lake were probably never killed with rotenone as they were in other nearby lakes.

13.3 White Sucker *Catostomus commersoni* (Lacepède)

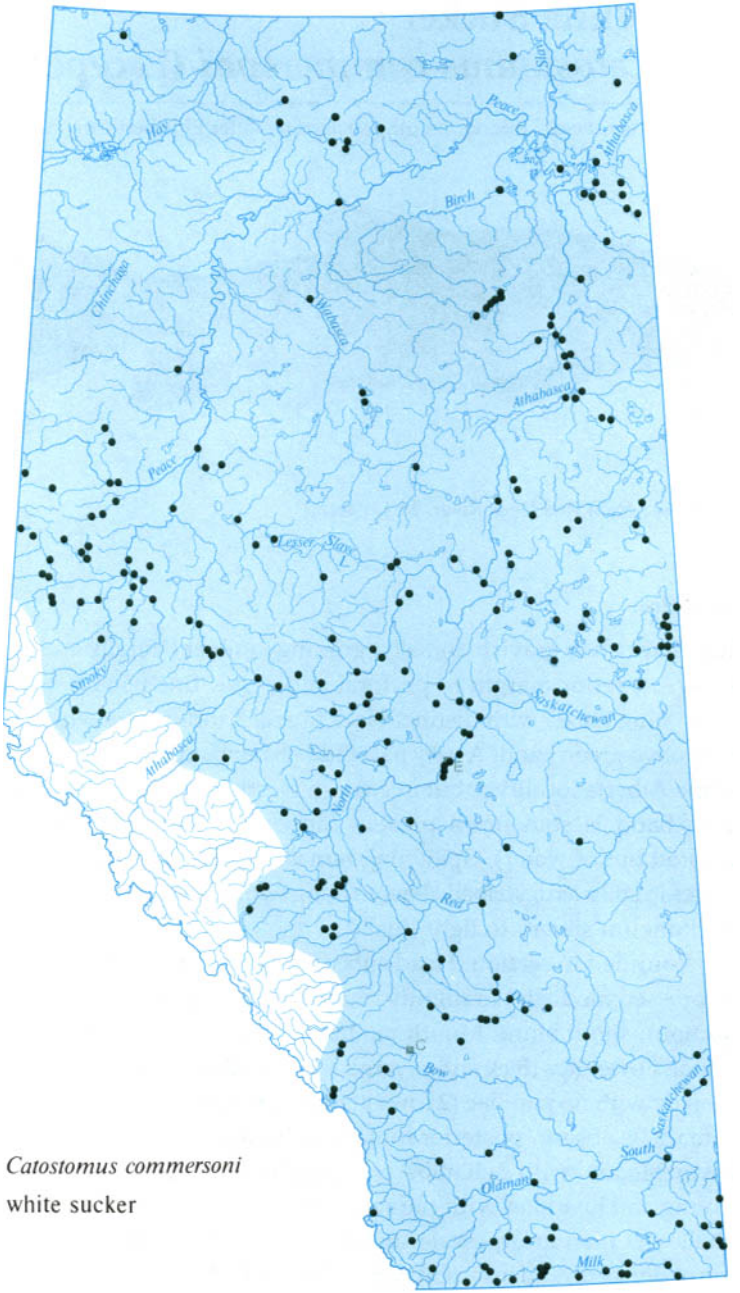
[*Cato stomus:* inferior mouth; *commersoni:* after Philebert Commerson]

White sucker from Red Deer River. M.J. Paetz.

Description

Color: Blackish or grayish dorsally, grading to silver laterally and ventrally. Anterior margin of pectoral and pelvic fins usually white. Spawning males with distinct black lateral band, above which is a pale olive-green band. A very pale reddish band occurs in males from some Alberta localities, but in eastern North America a bright reddish band is sometimes present (appearing somewhat bronze-colored out of water). Spawning females tend to resemble unripe males in color as described above. Young with 3 black lateral blotches. Peritoneum silvery to light dusky.

Body: Rounded in section. Head subconical and flattened (or slightly depressed medially) to slightly rounded dorsally (squarish in cross section); snout blunt. Mouth moderate in size and slightly subterminal. Lower lips thick and covered with papillae; midline cleft deep, usually with no papillae (2 rows at most) crossing in front. Anterior fontanelle absent, posterior fontanelle moderately long and wide. Swim bladder with 2 chambers. Lateral line complete and straight. Young and juveniles with caudal peduncle deeper and body depth shallower than in largescale suckers; ratio of distance between origin of dorsal fin and insertion of pelvic fin to depth of caudal peduncle 1.9-2.5 in individuals less than 25 cm fork length. Area in front of dorsal fin rounded in cross section. Lateral-line scales 55-85 (usually



Map 13.3 Distribution of white sucker in Alberta.

58-68); scales above lateral line 9-11; scales around caudal peduncle 16-20; dorsal fin rays 10-13 (usually 11 or 12); gillrakers 20-27.

Size: Maximum length 76 cm and weight 17.5 kg.

Alberta

Gillrakers about 24-27. Vertebral number in 264 specimens from throughout Alberta: 44 in 3 specimens, 45 in 12, 46 in 93, 47 in 124, 48 in 29, and 49 in 3.

Maximum lengths noted in Alberta are 52.6 cm fork length (2.1 kg) from Lesser Slave Lake and 55 cm fork length (1.8 kg) from Sturgeon Lake, west of Valleyview.

Distribution

● British Columbia through the southern Northwest Territories to Nova Scotia and New Mexico to northern Georgia.

■ Known throughout Alberta in Hay, Slave, Peace, Athabasca, Beaver, North Saskatchewan, Battle, Red Deer, Bow, Oldman, South Saskatchewan, and Milk river drainages (see Map 13.3).

Biology

The white sucker is found in rivers and shallow and deep lakes. It is exceptionally tolerant to a wide diversity of environments but does not extend as far into the Rocky Mountains as does the longnose sucker; for example, unlike the longnose sucker, it is very rare in Abraham Reservoir (Tebby 1974). Spawning usually occurs from mid-May to early July, starting at water temperatures of about 10° C. Creeks (clear or turbid) are generally used for spawning but beach spawning in lakes is not uncommon (and is necessary in many Alberta lakes). Average size females produce about 10,000-35,000 eggs during a spawning season. Maturity is reached at about age 5 or 6, with a life span of up to 14-17 years. They are bottom feeders, consuming molluscs, immature insects, and algae. The young, after the yolk sac is absorbed, feed near the surface for a short period. In the early life stage the mouth is terminal and feeding occurs mostly on plankton. White suckers hybridize with longnose suckers in Upper Kananaskis Lake (Nelson 1973b) and Abraham Lake (Tebby 1974) and with largescale suckers in the Peace River system of Alberta (Nelson 1974). The latter cross is relatively common in the area of sympatry of the parental species in British Columbia. White suckers have also been known to mate with mountain suckers in the United States. The first recorded case of hermaphroditism in

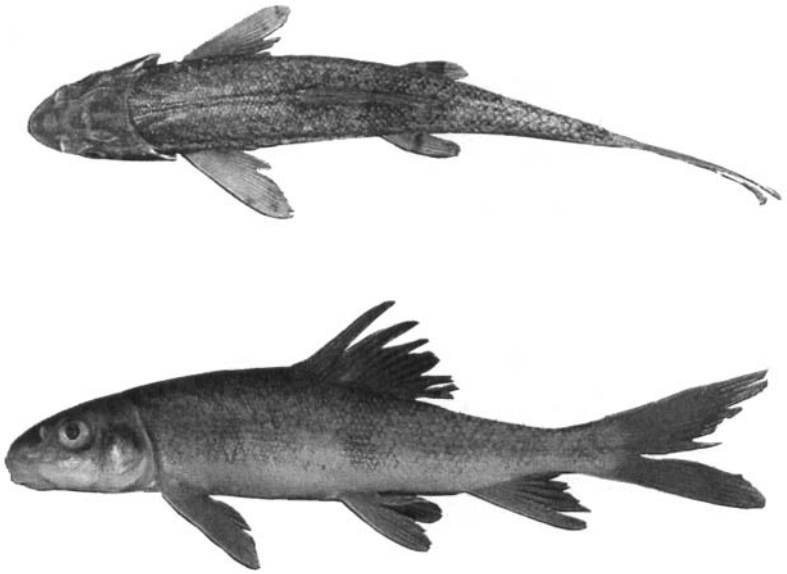
suckers was reported for a white sucker from the Athabasca River. The 42 cm bisexual individual had paired ovotestes, and it is possible that both gonads might eventually have become functional (Sikstrom et al. 1975). Information on their spawning, migration, feeding, and growth in Alberta may be found in Bond (1972), Clifford (1972), Barton (1980), and Walton (1980).

Historical Note

The description by B.G.E.C. Lacepède in 1803 of *Cyprinus commersonnii* is probably this species. Apparently the collections of Commerson from the East Indies were confused with those of another worker. The type locality is unknown. The white sucker was first noted from Alberta by Eigenmann (1895) at Medicine Hat and Calgary. Noted from the Athabasca Lake area by Kendall (1924).

13.4 Largescale Sucker *Catostomus macrocheilus* Girard

[*Cato stomus:* inferior mouth; *macro cheilus:* large lip]



Largescale sucker juveniles, 89 mm standard length, from Peace River at Dunvegan.

Description

Color: Dark olive to black dorsally and laterally, white or yellowish ventrally. Anterior margin of pectoral and pelvic fins usually dark, rarely white. Spawning individuals with a golden tinge dorsally and laterally and with a black lateral band above which is an iridescent light olive-green band. A yellow stripe lies below the black band (all color differences are much more distinct in males than in females). Young usually with 3 faint black lateral blotches (may be absent or moderately distinct). Peritoneum dusky silvery to light dusky black.

Body: Rounded to slightly compressed. Head subconical and slightly rounded dorsally; snout blunt. Mouth moderate in size and slightly

Map 13.4 Distribution of largescale sucker in Alberta.

subterminal. Lower lip thick and covered with papillae; midline cleft deep, usually with no papillae crossing in front. Anterior fontanelle absent, posterior fontanelle moderately long and wide. Swim bladder with 2 chambers. Lateral line complete and straight. Young and juveniles with caudal peduncle narrower and body depth greater than in longnose, white, and mountain suckers; ratio of distance between origin of dorsal fin and insertion of pelvic fin to depth of caudal peduncle 2.6-3.4 in individuals over 4 cm fork length. Small ridge in front of dorsal fin. Lateral line scales 62-81; scales above lateral line 11-15; scales around caudal peduncle about 17; dorsal fin rays 12-17 (usually 14 or 15 in Alberta); gillrakers 25-32.

Size: Maximum length 61 cm.

Distribution

● Coastal streams from British Columbia to Oregon and Peace River system of British Columbia and Alberta. Widespread in eastern British Columbia in Fraser and Columbia river drainages.

■ Restricted in Alberta to the Peace River system. Known from Peace River at Dunvegan, Simonette River, Wapiti River, Pinto Creek, and Big Mountain Creek (see Map 13.4). No adults have been recorded in Alberta, only young and juveniles.

Biology

The largescale sucker is found in rivers and deep lakes (known in Alberta only from rivers). They usually spawn in May and June, shortly after the longnose sucker. Spawning generally occurs in creeks (clear or turbid), starting at water temperatures of about 10°C. Maturity is reached at age 5. They are bottom feeders, consuming mainly molluscs, immature insects, and algae. The young live near the surface for a short period in their early life when the mouth is terminal; they feed extensively on diatoms, rotifers, and cladocerans. Largescale suckers hybridize with white suckers in Alberta and British Columbia (Nelson 1974).

Historical Note

C.F. Girard first described the largescale sucker from Astoria, Oregon, in 1856 as *Catostomus macrocheilus*. It was first taken in Alberta by R.B. Miller and M.J. Paetz on 15 August 1956, at Dunvegan, Peace River.

13.5 Mountain Sucker *Catostomus platyrhynchus* (Cope)

[*Cato stomus:* inferior mouth; *platy rhynchus:* flat snout]

Mountain sucker from Pothole Creek at Magrath, Oldman River drainage, 9 August 1977 (UAMZ 4000). Note: this specimen is infected with the parasite *Neascus* (see "Biology" of the longnose sucker 13.2).

Description

Color: Dark greenish or dusky brownish dorsally and laterally, finely speckled with black; light yellowish ventrally. Darkish lateral band usually present from snout to base of tail. Breeding males with red or orange lateral band above the blackish band. Young and sometimes adults with 3 black dorsolateral saddles (these fade quickly in museum specimens). Caudal interradial membranes sparsely pigmented. Peritoneum jet black or dusky (with some silver showing through).

Body: Rounded in section. Head flattened to slightly rounded and conical. Mouth moderate in size and subterminal. Lower lip flat, thick, and broad; covered with papillae; midline cleft shallow, with 3-5 rows of papillae crossing in front. Distinct notch at each corner of mouth between upper and lower lip (see Fig. 13b). Edge of lower jaw with a cartilaginous sheath. Anterior fontanelle absent, posterior fontanelle usually reduced to a narrow slit. Membranous stays connecting inner rays of pelvic fins to body; distinct pelvic axillary process (fleshy projection originating dorsal to the first pelvic rays—it is absent or indistinct in other Alberta suckers). Swim bladder small, with 2 chambers. Length of intestine usually long, longer than 5 times standard length and extensively coiled. Lateral line complete but

Map 13.5 Distribution of mountain sucker in Alberta.

not distinct. Lateral line scales usually 70-90 (rarely over 98); scales above lateral line 15-20; scales around caudal peduncle about 23; dorsal fin rays 9-12 (usually 10 or 11); gillrakers 23-37.

Size: Maximum length 23 cm.

Alberta

Vertebral number in 67 specimens from Milk River to North Saskatchewan River: 43 in 1 specimen, 44 in 1, 45 in 10, 46 in 40, 47 in 13, and 48 in 2.

Maximum known length in Alberta is 19.6 cm fork length from Abraham Lake (Tebby 1974; UAMZ 3374).

Catostomus columbianus, the bridgelip sucker, which occurs in the Columbia and Fraser river drainages of British Columbia, is the only nearby sucker likely to be confused with our mountain sucker. It lacks the large mouth notches and has more rays in the dorsal fin (11-14, usually 12).

Distribution

● Alberta and southwestern Saskatchewan to northeastern California and northwestern Nebraska; common in much of Utah and Wyoming with isolated populations in much of the rest of the western United States and in British Columbia (lower Fraser, Similkameen, and North Thompson rivers in British Columbia).

■ Known from Alberta in North Saskatchewan, Red Deer, Bow, Oldman, upper South Saskatchewan, and Milk river drainages (see Map 13.5).

Biology

The mountain sucker is most commonly found in mountain streams, often in swift waters at high altitudes (up to about 2560 m in the United States), in both clear and turbid waters. However, in Alberta it is more closely associated with streams in the foothills and in the adjacent plains. Although of relatively restricted range, it is common in many areas, especially in the Milk River. Very little is known of even its general biology. Feeding occurs primarily on filamentous algae and diatoms, but some invertebrates are also consumed. The long intestine and cartilaginous sheath in the mouth adapt the species for eating algae in streams. Mountain suckers spawn in late spring and early summer (probably June and July). Tebby (1974) noted spawning on 10 July in a tributary to Abraham Lake. The life span of individuals is not

known to be longer than 9 years. Mountain suckers have been found to hybridize with longnose and white suckers in Wyoming and South Dakota.

Historical Note

E.D. Cope first described the mountain sucker from Provo, Utah (either the Provo River or Utah Lake), in 1874 as *Minomus platyrhynchus*. Cope may have described this species in 1872 under other names but his earlier names are not recognized because of doubt as to the identity of the specimens. Mountain suckers were first taken in Alberta by R.B. Miller and C. Ward on 8 August 1950, from the North Fork of the Milk River, near Del Bonita. Scott (1957) published the first record in Alberta based on specimens that he collected in 1956 in a tributary of the Waterton River and from the North Fork of the Milk River, recognizing it as *Pantosteus jordani*. *Pantosteus*, a taxon to which this species belongs, is now recognized as a subgenus of *Catostomus*.

13.6 Silver Redhorse *Moxostoma anisurum* (Rafinesque)

[*Moxo stoma:* to suck, mouth; *anis urum:* unequal tail]

Silver redhorse from South Saskatchewan River near Medicine Hat. Photo courtesy of G. Clements.

Description

Color: Bronzy-olive dorsally, silvery laterally and sometimes with goldish reflections. No dark spots on scales in adult. Fins clear or slate-colored. Young with 2 or 3 black lateral blotches. Peritoneum silvery, with a few black spots.

Body: Slightly compressed. Head conical, moderately rounded dorsally, and slightly longer than in shorthead redhorse, *M. macrolepidotum*. Mouth moderate in size and subterminal. Hind margin of lower (posterior) lip forming a deeply incised angle (V-shaped, not a straight line, see Fig. 13b); lower lip relatively small and thin; plicae (elongated folded ridges) of lips broken up into papilla-like elements (small conical fleshy projections). Outer margin of dorsal fin rounded outwardly in adults, straight in young. Swim bladder divided into 3 chambers. Lateral line complete and straight. Lateral-line scales 38-48 (usually 40-42); dorsal fin rays 13-18 (although this species has 15-17 principal dorsal fin rays in Canada according to Scott and Crossman 1973, the largest Alberta specimen has 13 rays).

Size: Maximum length 63 cm and weight 3.7 kg.

Map 13.6 Distribution of silver redhorse in Alberta.

Alberta

The vertebral number in 14 specimens from the North Saskatchewan River: 41 in 6 specimens, 42 in 7, and 43 in 1.

Maximum known length in Alberta is 59.4 cm fork length (64.3 cm total length) and 3.66 kg (UAMZ 7396—angled by George Sterling 4 September 1991 from the North Saskatchewan River at the junction with White Earth Creek). The second longest specimen is 54.5 cm fork length and 3.1 kg (UAMZ 4474—angled by Tom D. Boag 25 August 1980 from the North Saskatchewan River in Edmonton).

Distribution

● Alberta to southern Quebec and Missouri to northern Georgia.

■ Known in Alberta only from the North Saskatchewan River between Devon and the Sturgeon River (but probably occurs throughout the river in Alberta up to the outlet of Wabamun Lake) and the South Saskatchewan River at Medicine Hat (see Map 13.6). It was not reported from the North Saskatchewan River in Saskatchewan by Atton and Merkowsky (1983); it has, however, subsequently been found but, in contrast to the shorthead redhorse, is very rare (F.M. Atton, personal communication).

Biology

The silver redhorse frequents large rivers, especially pools or areas of slow gradient. It is occasionally found in lakes, but has not yet been found in any Alberta lakes. Individuals usually spawn in clear running water in the late spring. Maturity is reached at age 5. The silver redhorse is a bottom feeder, consuming mainly immature insects. Young-of-the-year have been taken with shorthead redhorse young-of-the-year at Fort Saskatchewan. Little is known of the habits of the silver redhorse in Alberta.

Historical Note

C.S. Rafinesque first described the silver redhorse in 1820 from the Ohio River as *Catostomus anisurus*. It is the type species for the genus *Moxostoma*. The silver redhorse was first noted in Alberta by Henderson and Peter (1969) from nine specimens collected in 1963 at Medicine Hat. Specimens were collected later by Colin Paterson from Fort Saskatchewan, 26 September 1963 (but not identified until 1969).

13.7 Shorthead Redhorse *Moxostoma macrolepidotum* (Lesueur)

[*Moxo stoma:* to suck, mouth; *macro lepidotum:* large scaled]

Shorthead redhorse from lower Paintearth Creek, Red Deer River drainage. Photo courtesy of RL & L Environmental Services Ltd.

Description

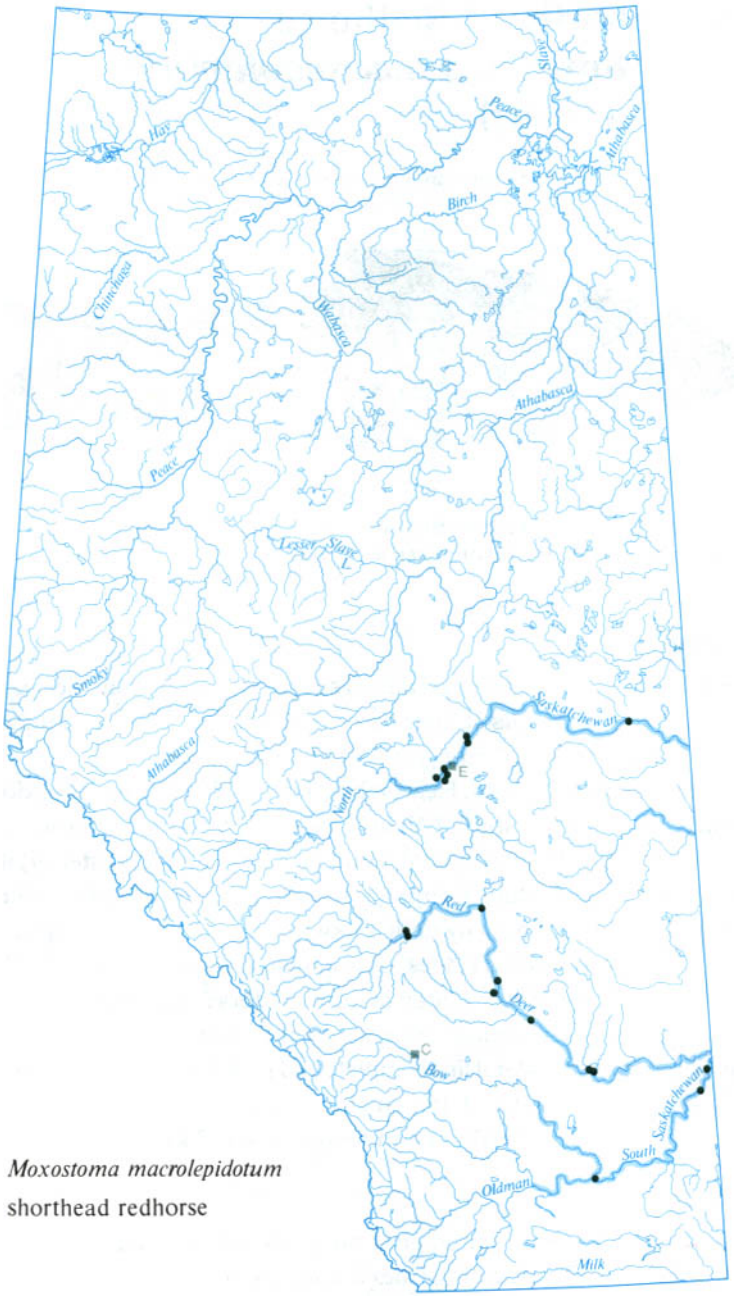
Color: Olivaceous dorsally, golden to silvery sheen laterally. Scales in adult with dark spots at their bases. Fins with reddish or orangish color. Peritoneum silvery, with a few black spots.

Body: Slightly compressed. Head subconical, moderately rounded dorsally, and slightly shorter than in silver redhorse, *M. anisurum*. Mouth small and subterminal. Hind margin of lower (posterior) lip in juveniles and adults forming a straight line (see Fig.13b)(anteriorly curved in young); lower lip moderate in size and thick; lips plicate (elongated folded ridges, occasionally broken into papilla-like elements posteriorly). Outer margin of dorsal fin falcate (sickle-shaped) in adults, almost straight in young. Swim bladder divided into 3 chambers. Lateral line complete and straight. Lateral-line scales 40-47; dorsal fin rays 11-15 (usually 12-14).

Size: Maximum length 61 cm and weight about 2 kg.

Alberta

Meristic counts in six specimens from the North Saskatchewan River near Edmonton, including from the mouth of the Sturgeon River, are as follows: scales along lateral line 44-46; above lateral line 6 or 7; around caudal peduncle 12-14; dorsal fin rays 11-13; total number of gillrakers 20-23. Vertebral number in 45 specimens from the



Map 13.7 Distribution of shorthead redhorse in Alberta.

North Saskatchewan River: 41 in 1 specimen, 42 in 23, 43 in 20, and 44 in 1.

Maximum length noted in Alberta is 39.5 cm fork length from the Red Deer River west of Stettler, 13 August 1973 (UAMZ 3459), and 40.6 cm fork length from the Sturgeon River near Gibbons (by Don Doll, Renewable Resources Ltd., 1971). Larger specimens undoubtedly exist.

Distribution

● Alberta to Quebec and eastern Oklahoma to eastern New York.

■ Known from scattered localities in central and southern Alberta in the North Saskatchewan, Battle, Red Deer, lower Bow, Oldman, and South Saskatchewan rivers and their immediate tributaries (see Map 13.7).

Biology

The shorthead redhorse is found in large rivers and streams; in areas outside Alberta it is also found in lakes. Individuals usually spawn in clear creeks in the spring (probably mostly in late May), starting at water temperatures of about 10°C, slightly before the silver redhorse. Maturity is reached at age 3. Shorthead redhorse are bottom feeders, consuming mainly immature insects. Young-of-the-year have been taken with silver redhorse young-of-the-year at Fort Saskatchewan. Little is known of the habits of the shorthead redhorse in Alberta.

Historical Note

C.A. Lesueur first described the shorthead redhorse from the Delaware River in 1817 as *Catostomus macrolepidotus*. The occurrence of the shorthead redhorse in Alberta has been known for some time, certainly as early as 1951 by R.B. Miller. Specimens were taken in 1956 by M.J. Paetz from the Red Deer River near Steveville and from the mouth of the Sturgeon River near Fort Saskatchewan. It was known previously from Alberta as the northern redhorse.

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14 Bullhead Catfish Family—Ictaluridae

SPECIES OF THIS catfish family are confined to North and Central America. Members of other catfish families, some of which are marine, occur in South America, Africa, Asia, and parts of Europe and Australia. The greatest number of species of catfish in the family Ictaluridae occur in the United States in the Mississippi River drainage. This freshwater family contains about 45 species. Seven species occur in Canada with one in Alberta (two in British Columbia, both the result of introductions; none in the Northwest Territories; and five in Saskatchewan).

Presently, the only species of the bullhead catfish family in Alberta is the stonecat, *Noturus flavus*; however, there is some evidence that another species, the channel catfish, *Ictalurus punctatus*, occurred in Alberta until about 200 years ago. Bones of this species that are a few thousand years old have been found in the South Saskatchewan River, downstream from Medicine Hat at the Cactus Flower Site (Michael C. Wilson, personal communication; Graham et al. 1987:417). Of more recent occurrence, Gabriella Praeger (personal communication) found the cleithrum (shoulder bone) of what is probably a channel catfish at a site on the North Saskatchewan River southeast of Elk Point that was a fur trading post occupied between 1792 and 1779. Although fur traders could have transported channel catfish into Alberta for food it is more probable that they caught the fish locally. Channel catfish have also been recorded in eastern Saskatchewan (Atton and Merkowsky 1983; Atton 1985).

Individuals of some species of this family in the United States exceed 1.3 m in length and may weigh more than 45 kg while individuals of other species seldom exceed 8 cm. Several species are important as

sport fish. As a group, catfish generally feed at night on bottom-dwelling insects and snails. Spawning occurs in the spring and early summer; males guard the nest.

Members of this family have 8 sensory barbels on the head, 8-13 branchiostegal rays, 37-53 vertebrae, a spinous ray on the dorsal fin and on each pectoral fin, an adipose fin, and a naked skin. Members of the madtom genus (*Noturus*), of which the Alberta species is a member, have a venom gland which connects to the pectoral spines and they can inflict a painful wasplike sting.

Ictalurids are placed in the order Siluriformes along with 30 other catfish families. Three species of the bullhead catfish family are blind.

14.1 Stonecat *Noturus flavus* Rafinesque

[*Not urus:* back tail, in reference to the connection of the adipose fin with the caudal fin; *flavus:* yellow]

Stonecat from lower Milk River. Photo courtesy of W.E. Roberts.

Description

Color: Purplish- to yellowish-brown dorsolaterally, creamy light color ventrally. Light color on dorsal and adipose fins and margin of caudal fin (especially enlarged on dorsal lobe). Peritonium silvery.

Body: Rounded in section. Head broad and flattened dorsally; space between eyes about 5 times eye diameter; eyes very small; mouth subterminal and wide (about as wide as distance between eyes and ending well in front of eye); 8 long barbels (4 under the chin, 2 supported by the maxillae at the corner of the mouth, and 2 in front of the nostrils). Teeth on upper jaw (premaxillae) and lower jaw numerous and short; the rows on the premaxillae extend backward and to the side. Gill membranes extending forward and narrowly joined to each other. Spines at leading edge of pectoral and dorsal fins; these are inconspicuous without taking away the fin membrane. Pectoral spines smooth except for variously developed serrations on anterior edge (outer side away from the rest of fin); serrations strongest on distal half of spine and serrated points facing inward toward head (fin membrane must be dissected away to see these serrations). Origin of dorsal fin far in front of insertion of pelvics. Lateral line faint anteriorly and straight. Adipose fin low and joined to the caudal fin

Map 14.1 Distribution of stonecat in Alberta.

by a small fleshy ridge (no posterior free end, only a notch); caudal fin somewhat rounded with a straight posterior edge. Dorsal fin with 1 short spine and about 6 soft rays and anal fin with 15-18 soft rays; gillrakers distinct, about 8; branchiostegal rays 9. Vertebral number in 12 specimens from Alberta: 42 in 4 specimens, 43 in 7, and 44 in 1.

Size: Maximum length 31 cm.

Alberta

Maximum length noted in Alberta is 25 cm fork or total length in a specimen caught near the bridge over Deer Creek in the Milk River drainage (UAMZ 6634).

Distribution

● Alberta and southern Quebec and southward from Oklahoma to Tennessee.

■ Known in Alberta only from the Milk River or the lower reaches of some of its tributaries (e.g., Red Creek) (see Map 14.1).

Biology

The stonecat is adaptable to many habitats. It is most commonly associated with boulders in deep pools and over rocky bottoms in currents or riffles of large streams, both turbid and clear. Stonecats feed primarily on aquatic insects and sometimes on small fishes. They are thought to use their barbels to help locate food (through a sense of smell or taste) and probably feed mostly at night. Spawning is thought to occur in June and July and the eggs are apparently guarded by one or both parents.

It is occasionally caught by anglers.

Historical Note

C.S. Rafinesque first described the stonecat in 1818 from the Ohio River as *Noturus flavus*. It is the type species for the genus. Eigenmann (1895) noted verbal reports of the species from the Medicine Hat vicinity (probably from the Milk River drainage) while the first specimens were recorded by Nursall and Lewin (1964), caught 20 June 1962, west of Wildhorse, in the Milk River. Willock (1968) noted additional specimens from the Milk River.

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15 Pike Family—Esocidae

MEMBERS OF THE pike family occur in northern parts of the Northern Hemisphere, in Europe, Asia, and North America. Their greatest diversity occurs in eastern North America. This freshwater family contains five species, four of which range into Canada, but only one species, the northern pike, is known in Alberta and in the two adjacent provinces.

Because of the considerable color variation found in northern pike, many people (e.g., Whitehouse 1919) have suspected that there is more than one species in Alberta. However, it is almost certain that color differences represent variation within just the one species, the northern pike *Esox lucius*.

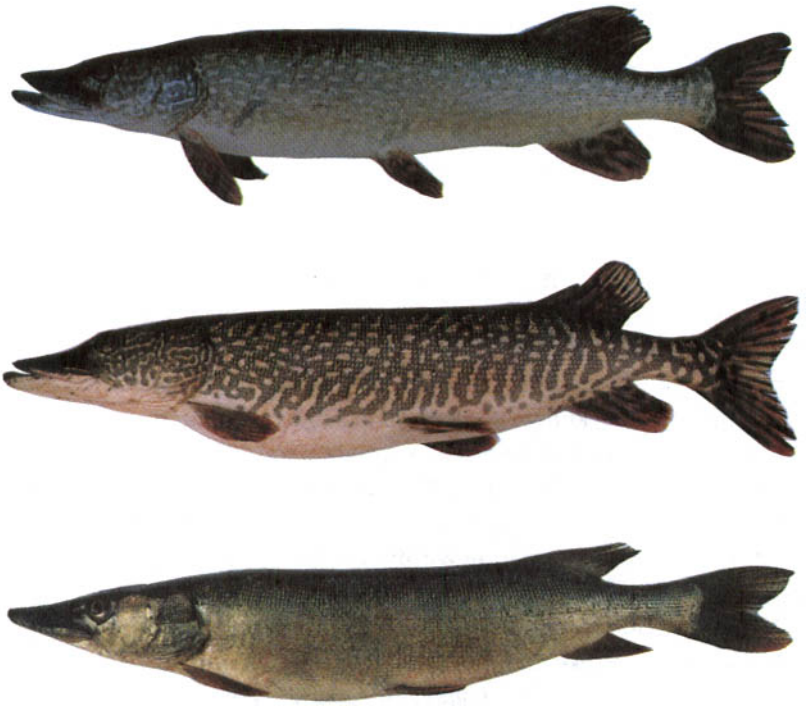
Various members of this family are important sport fishes, particularly the northern pike and muskellunge (or maskinonge). The name pickerel, usually applied to walleye in Alberta, is properly applied to relatively small members of the pike family confined to eastern North America (i.e., redfin, grass, and chain pickerels).

The closest relatives to this family are small freshwater fish, the mudminnows and Alaska blackfish (family Umbridae—of which one, the central mudminnow, *Umbra limi*, is found in easternmost Saskatchewan in the Saskatchewan River drainage). The pike family is usually placed in the order Salmoniformes and considered to be the most primitive family in this order; it and its umbrid relatives appear to be relatively distant, however, to the other members of the order such as whitefish and trout.

The oldest known fossils of the family are of *Esox tiemani*, found in Alberta in Paleocene beds which are about 62 million years of age (Wilson 1980, 1984). This ancient species is relatively similar in appearance to the northern pike.

15.1 Northern Pike (or Jackfish) *Esox lucius* Linnaeus

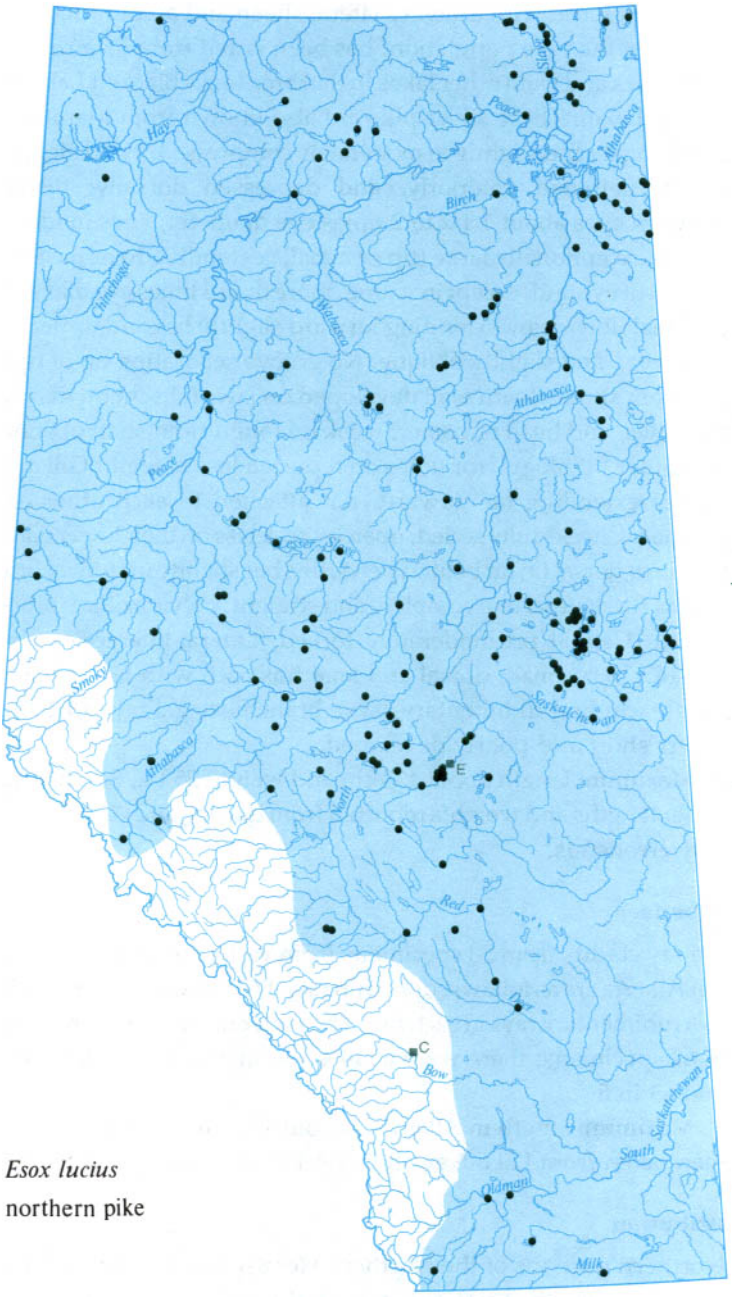
[*Esox:* a kind of pike; *lucius:* the Latin name for the pike]



Three color phases of northern pike. Christina River. M.J. Paetz. Wabamun Lake. M.J. Paetz. Blackett Lake, silver mutant. Photo courtesy of H.J. Norris.

Description

Color: In adults olive or brownish-green dorsally, large irregular white or greenish spots laterally in oblique rows. Young with darkish green oblique bars on silvery background. Horizontal black bar in front of and behind the eye and a vertical bar beneath the eye; the horizontal bar disappears first with growth. Young less than 4 cm long have a horizontal stripe beneath the eye instead of the vertical bar. Juveniles and adults have dusky spots on the median fins. Peritoneum silvery.



Map 15.1 Distribution of northern pike in Alberta.

A Mutant form, with a silvery lateral sheen and accounting for up to 10% of the pike population, has been noted from Primrose and Cold lakes and from other lakes in that area (e.g., Blackett Lake near Moose Lake). These silver pike are also known from Manitoba.

Body: Elongate and slightly to moderately compressed. Head elongate, broad, flattened anteriorly, and depressed dorsally; distance between eyes about 1 1/2 to 2 times eye diameter; eyes moderate; mouth exceptionally large (tip of maxilla extending to or past front margin of eye and, except in young, more than 3 times eye diameter), terminal (lower jaw extending forward slightly beyond upper jaw, however), and slightly oblique. No groove separating tip of upper jaw from snout. Teeth well developed on jaws (absent on maxilla), palatines, and head of vomer; weak on tongue and shaft of vomer; see under "Biology" for notes on reported loss of teeth. Gill membranes extending far forward, not attached to each other or to isthmus. Cheeks fully scaled, opercles scaleless on their lower halves. Origin of dorsal fin far behind pelvic fins but slightly in front of origin of anal fin. Lateral line complete and straight. Pelvic axillary process absent. Caudal fin moderately forked. Lateral-line scales about 105-145, very small; dorsal and anal fins each with fewer than 20 rays (excluding rudimentary rays); branchiostegal rays 13-16; gill-rakers short and poorly developed.

Size: Maximum length about 133 cm and weight 25 kg. Substantially larger lengths and weights reported from Europe and Asia are probably erroneous.

Alberta

Fin ray counts from 50 specimens from various localities throughout Alberta are as follows: dorsal fin rays 17-19 and anal fin rays 13-16 (4-6 rudimentary rays in each fin). The vertebral number was counted in 62 specimens: there were 60 in 4 specimens, 61 in 17, 62 in 33, and 63 in 8.

Maximum length in Alberta is about 122 cm (19.5 kg) in a specimen taken from Lake Newell in 1953 in the commercial fishery.

Distribution

● Northern portions of the Northern Hemisphere including Europe and Asia. In North America from Alaska and northeastern British Columbia to Missouri and Labrador.

■ Common throughout most of Alberta in Petitot, Hay, Slave, Peace, Athabasca, Beaver, North Saskatchewan, Battle, Red Deer, Bow, Oldman, South Saskatchewan, and Milk river drainages (see Map 15.1). It is uncommon in the Rocky Mountains and adjacent foothills.

Biology

Northern pike prefer relatively shallow, weedy, clear waters and although they occur primarily in lakes and marshes, they are common in streams with a slow to moderate current. In Alberta a large number were formerly caught commercially and used as food for ranch mink within the province; they continue to be exported for human consumption, especially to France. Large individuals are usually taken from Winefred, Seibert, May, Newell, Cold, Ridge, Touchwood, and Athabasca lakes. In feeding, northern pike are ambush predators; they do not usually actively swim searching for food. Their diet is largely made up of fish, crustaceans, insects, and other animals, such as young muskrats and ducklings. In Alberta, very young individuals have been found feeding on crustaceans such as amphipods while young-of-the-year have been found feeding on crustaceans, minnows, suckers, trout-perch, and brook stickleback (pike as small as 3 cm have been found feeding on newly hatched suckers, W.E. Roberts, personal communication).

Northern pike spawn in the early spring, often before the ice has completely left the lakes. Spawning areas typically are shallow marshes connected to lakes or flooded vegetation in shallow bays. The eggs stick to the vegetation; young hatch out with a yolk sac in about 2 weeks and remain attached to vegetation for about the first week after hatching. This may serve to keep the young off the bottom where they might encounter siltation and low oxygen concentrations. Whether northern pike can only occur in waters with vegetation or upright objects on which to attach their eggs is uncertain. They are probably a little over 1 cm in length at hatching and in Alberta they may reach a length of at least 28 cm in their first year.

It is a common myth that northern pike occasionally lose their teeth. While they shed some of their teeth, including some of the long canine-like ones, they are not all shed at the same time and lost ones are replaced. Also, swollen gums may give the appearance that some teeth have been lost. The presence of teeth can be easily verified by carefully feeling in their mouth. Decreased angling success, sometimes attributed to loss of teeth, has other explanations.

Pike are the final hosts of several tapeworms including four species of the genus *Triaenophorus*. One species, *T. crassus*, is harmless to man but its larval stage causes unsightly cysts in the flesh of whitefish and ciscoes. Larvae of another, *T. nodulosus*, occur in the liver of burbot, perch, or other fish. In pike, the adult tapeworms are found in the intestine and may reach lengths of up to 38 cm in late fall to early spring. Miller (1945b, 1952a) reviews the tapeworms' life history. Pike in Alberta are also host to the larvae of the broad tapeworm, *Diphyllobothrium* (=*Dibothriocephalus*) *latum*, the only fish parasite in Alberta known to infect humans (Anthony 1967). These larvae are killed if the fish is cooked thoroughly.

References to studies on northern pike include the following: Chapman and Mackay (1984), Christiansen (1976), Craig and Smiley (1986), Crossman and Casselman (1987), Diana (1979), Diana (1987), Diana et al (1977), Makowecki (1973), Medford and Mackay (1978), Miller (1948), Nursall (1973), Roberts (1975b), Robinson (1989), Sullivan (1985), Turner (1984), and Turner and Mackay (1985).

Angling

Northern pike are an extremely popular game fish, and Alberta is generously supplied with them. Pike will readily take a wide variety of plugs, spoons, spinners, bait, and artificial flies which may be cast or trolled in the shallows of lakes near weed beds or lily pads. Angling success is usually best after the spawning season in May and June although fishing is generally good throughout the entire open water season. Attention has been given to the trophy aspect of northern pike fishing in Alberta with several lakes being declared 'trophy lakes' that are subject to special angling regulations. Fishing for pike during the winter is also becoming a popular sport in waters close to population centers.

Historical Note

C. Linnaeus first described the northern pike in 1758 from Europe as *Esox lucius*, but it was well known long before then. It was first reported in Alberta by Eigenmann (1895) at Medicine Hat as *Lucius lucius*. Whitehouse (1919) reported northern pike in the Red Deer, Saskatchewan, Peace, and Athabasca rivers. Kendall (1924) noted it from Lake Athabasca while Bajkov (1927) recorded it from several areas in Jasper Park.

16 Trout Family—Salmonidae

MEMBERS OF THE trout family are native to cold waters throughout the Northern Hemisphere. Most species occur only in fresh water but many are anadromous or have anadromous members (an anadromous fish spends part of its life in salt water but spawns in fresh water). Salmonids have been successfully introduced throughout the world onto all continents except Antarctica. In addition, many species have been introduced to areas within their native range.

Three subfamilies are recognized, each of which has representatives native to Eurasia and North America. The number in parentheses after each genus is an estimate of the number of valid species that exist.

The subfamily Coregoninae (inconnu, cisco, and whitefish) contains three recognized genera, *Stenodus* (1), *Prosopium* (6), and *Coregonus* (25).

The subfamily Thymallinae (grayling) contains a single genus, *Thymallus* (4).

The subfamily Salmoninae (lenok, taimen, char, trout, and salmon) contains six recognized genera, *Brachymystax* (1), *Hucho* (3), *Salmothymus* (3), *Salvelinus* (10), *Salmo* (5), and *Oncorhynchus* (11). For differences of opinion on the generic placement of species of Pacific trout see "Historical Note" in Section 16.9 for rainbow trout (*Oncorhynchus mykiss*).

In the family Salmonidae, about 31 species are native to Canada while 11 are native to Alberta (about 18 in British Columbia; 14 in the Northwest Territories; and 7 in Saskatchewan).

Salmonids have 7-20 branchiostegal rays on the epihyal and ceratohyal, 57-75 vertebrae, cycloid scales, and an adipose fin. In addition, Alberta species share the following characteristics: body moderately

compressed (except in cisco and lake whitefish where it is usually strongly compressed); head region between eyes slightly to moderately rounded; space between the eyes roughly about equal to eye diameter (in young) to 1 1/2-times eye diameter (in adults); eyes moderate to large; mouth terminal, upper jaw occasionally projecting slightly forward, and slightly oblique (except as noted for the cisco and whitefishes); wide frenum (no continuous groove separating upper jaw from snout, premaxillaries not protrusible); gill membranes extending far forward, not attached to each other or to isthmus; pectoral fin on lower half of body and base slightly to moderately oblique; pelvic axillary process present; dorsal fin origin in front of pelvic fin insertion; adipose fin origin usually over middle of anal fin base; lateral line straight and complete (in bull trout it is usually very slightly decurved anteriorly); peritoneum silvery, often with small black spots.

There is considerable diversity in feeding habits within the salmonid family. Plankton is the major food of species such as the cisco which has a large terminal mouth with small teeth and numerous long gillrakers. Most whitefish feed on bottom fauna and show adaptations such as a small subterminal mouth with small teeth and relatively few short gillrakers. Some species, such as the lake trout, feed primarily on other fish and have a large terminal mouth with well developed teeth and relatively few short gillrakers. Other species, such as bull trout and brown trout, can feed on a wide variety of food items including planktonic, benthic, and surface invertebrates and on other fishes.

This family contains the majority of species important in the commercial and sport fishery in Canada. Chapter 1 on "Fishing in Alberta" and Chapter 2 "Fish Management in Alberta" give information on this topic.

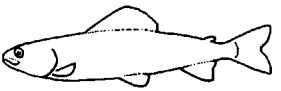
Salmonids are placed in the order Salmoniformes, along with the pike and numerous other families not represented in Alberta. Salmonids are relatively close relatives of the smelts (family Osmeridae).

Key to the 15 Species

Use the following key and Fig. 16a to identify the species of the trout family commonly found in Alberta. For an explanation of how to use the key, see Section 7.2. Seven additional species which occur adjacent to Alberta, have been introduced in Alberta but are no longer here, were previously reported but probably are not here, or have been introduced as a farm pond species are discussed in Appendix I and are not included in this key.

Scales along lateral line less than 100

Dorsal fin base equal to or greater than head length; teeth small



Arctic Grayling

Dorsal fin base shorter than head length; teeth inconspicuous to absent

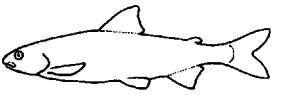
Nostril divided by double flap

Cisco

Shortjaw Cisco

Lake Whitefish

Nostril divided by single flap



Pygmy Whitefish

Round Whitefish

Mountain Whitefish

Scales along lateral line more than 110

Body with colored or light spots on dark background
Few or no teeth on shaft of vomer

Bull Trout

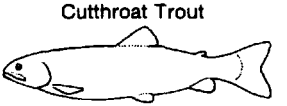
Brook Trout

Lake Trout

Body with dark spots on light background
Teeth along shaft of vomer

Golden Trout

Cutthroat Trout



Rainbow Trout

Brown Trout

Pictorial Guide to Salmonids of Alberta

Fig. 16a Outline drawings to supplement the Key to the salmonids in Alberta (Dolly Varden not shown).

1A Scales above lateral line fewer than 12; scales along lateral line fewer than 100; teeth on jaws small or absent..... .....GO TO 2A AND 2B.

1B Scales above lateral line more than 17; scales along lateral line more than 110; teeth on jaws well developed (subfamily SALMONINAE).....GO TO 8A AND 8B.

(FROM 1A)

2A Dorsal fin with 16 or more rays; dorsal fin base equal to (in young) or greater than (in adults) head length; maxilla with small teeth; adults with scattered distinct black spots usually restricted to anterior half of body; young with about 12 to 16 vertical parr marks (dark blotches) along lateral line (subfamily THYMALLINAE) .....**Arctic grayling—*Thymallus arcticus*.** SEE SECTION 16.7.

2B Dorsal fin with 15 or fewer rays; dorsal fin base shorter than head length (about 1/2 head length in young); maxilla toothless; body without distinct black spots; young with or without parr marks (subfamily COREGONINAE).....GO TO 3A AND 3B.

(FROM 2B)

3A Mouth terminal, jaws extending forward about equally or with lower jaw extending forward slightly past the upper jaw which has a sharp profile; gillrakers on first arch 37 or more (ciscoes) .....GO TO 4A AND 4B.

3B Mouth subterminal, upper jaw extending forward past lower jaw and profile of upper jaw blunt; gillrakers on first arch 33 or fewer.....GO TO 5A AND 5B.

(FROM 3A)

4A Gillrakers usually 43 or more (as low as 40); ratio of head length divided by snout to eye distance about 3.7-4.2..... .....**Cisco—*Coregonus artedi*.** SEE SECTION 16.1.

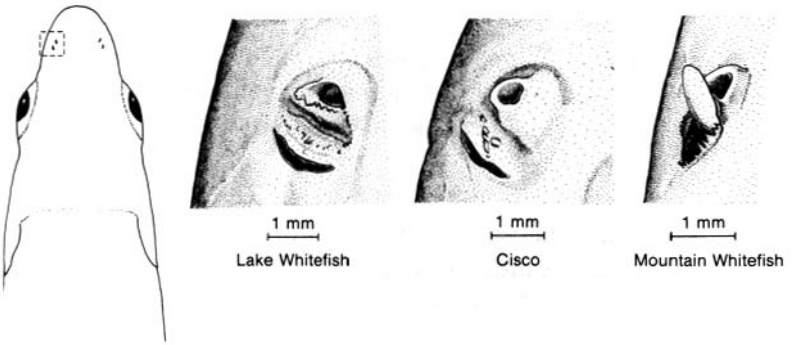


Fig. 16b Differences in the nostril flaps of lake whitefish, cisco, and mountain whitefish.

4B Gillrakers usually 42 or less (as high as 46); ratio of head length divided by snout to eye distance about 3.2-3.8..... .....**Shortjaw cisco—*Coregonus zenithicus*.** SEE SECTION 16.2.

(FROM 3B)

5A Each nostril with two flaps between the openings (see Fig. 16b); young without parr marks (these two features apply as well to the ciscoes); gillrakers on first arch usually 25 or more (lowest 23) .....**Lake whitefish—*Coregonus clupeaformis*.** SEE SECTION 16.3.

5B Each nostril with a single flap between openings; young with parr marks (dark blotches along the lateral line); gillrakers on first arch usually 24 or fewer (highest 26)..GO TO 6A AND 6B.

(FROM 5B)

6A Scales along lateral line fewer than 71; pyloric caeca fewer than 33; snout relatively roundish in dorsal profile..... .....**Pygmy whitefish—*Prosopium coulteri*.** SEE SECTION 16.4.

6B Scales along lateral line more than 74; pyloric caeca more than 50; snout relatively pointed in dorsal profile..... .....GO TO 7A AND 7B.

(FROM 6B)

7A Gillrakers on first gill arch usually 20 or more (lowest 19); scale rows around caudal peduncle 19 to 24, usually 20 to 23..... .....**Mountain whitefish—*Prosopium williamsoni*.** SEE SECTION 16.6.

7B Gillrakers on first gill arch usually 20 or fewer (highest 21); scale rows around caudal peduncle 24 to 27..... .....**Round whitefish—*Prosopium cylindraceum*.** SEE SECTION 16.5.

(FROM 1B)

8A Body, especially above the lateral line, with pale spots or markings (gray, red, orange, or white), never black spots in adults; teeth on head of vomer only (occasionally a few teeth on the anterior shaft of vomer in lake trout), not on posterior shaft; scales one row above lateral line more than 175..... .....GO TO 9A AND 9B.

8B Body, especially above the lateral line, with dark spots; teeth on head and along almost full length of shaft of vomer; scales one row above lateral line fewer than 165 (except in some cutthroat trout).....GO TO 12A AND 12B.

(FROM 8A)

9A Irregular whitish or grayish spots on back (seldom circular or wavy); spots on side usually without color; caudal fin deeply forked; pyloric caeca more than 80..... .....**Lake trout—*Salvelinus namaycush*.** SEE SECTION 16.15.

9B Circular or wavy markings on back; spots on side often with red, orange, and blue; caudal fin only slightly forked; pyloric caeca fewer than 50.....GO TO 10A AND 10B.

(FROM 9B)

10A Some red spots with blue halos on side, elongate or wavy pale or green markings on back; dorsal fin with dark markings; anterior tip of dorsal fin relatively rounded (specimens show-

ing both states of dorsal fin shape should be available to assess this character).....**Brook trout—*Salvelinus fontinalis*.**
SEE SECTION 16.14.

10B Circular red, orange, or white spots on side, no halo-like marks, no wavy markings on back; dorsal fin without markings; anterior tip of dorsal fin relatively pointed.....GO TO 11A AND 11B.

(FROM 10B)

11A When viewed from the side the eye is near dorsal margin of head, vertical distance from center of eye to top of head much shorter than distance from center of eye to nostril; upper jaw with downward curve; head appearing relatively broad in dorsal and anterior views; gillrakers stout, with strong teeth on inner margin. Note: bull trout are not in Chester Lake (Kananaskis River drainage), but do occur in western Alberta from Athabasca and Peace rivers southward (it can also occur far downstream in both rivers).....**Bull trout—*Salvelinus confluentus*.**
SEE SECTION 16.12.

11B Eye well below dorsal margin of head, vertical distance from center of eye to top of head about equal to distance from center of eye to nostril; upper jaw relatively straight; head appearing relatively compressed in dorsal and anterior views; gillrakers long, lacking teeth on inner margin. Note: Dolly Varden found in Alberta only in Chester Lake (Kananaskis River drainage) .....**Dolly Varden—*Salvelinus malma*.**
SEE SECTION 16.13.

(FROM 8B)

12A Dark spots, if present, on caudal fin confined to upper lobe; some of the large dark spots on body surrounded by pale halos; young with orange adipose fin and usually with a row of red spots (white when preserved) between parr marks along lateral line.....**Brown trout—*Salmo trutta*.**
SEE SECTION 16.11.

12B Dark spots on both lobes of caudal fin; no halos around dark body spots; young without orange on adipose fin and without

row of red spots along lateral line (the next three species are often impossible to separate adequately, hybrids frequently occur) .....GO TO 13A AND 13B.

(FROM 12B)

13A Reddish dash in crease on inside of lower jaw (visible externally); usually no marked whitish leading edge on anal and pelvic fins; dark spots below lateral line often closer and more numerous on posterior half of body than on anterior half; usually no broad red band on sides of adults; basibranchial teeth usually present ....**Cutthroat trout—*Oncorhynchus clarki* (=*Salmo clarki*)**.
SEE SECTION 16.8.

13B Reddish dash pale or absent on inside of lower jaw; whitish border usually present on anal and pelvic fins; dark spots below lateral line about equally common on anterior and posterior halves of body; broad red bands on sides often present; basibranchial teeth usually absent.....GO TO 14A AND 14B.

(FROM 13B)

14A Relatively numerous small roundish dark spots above and below the lateral line and on a darkish background; sides and belly silvery to yellowish-green; parr marks usually present only in young; usually only an indistinct white tip on the dorsal fin in adults; occur in a variety of environments.....
Rainbow trout—*Oncorhynchus mykiss* (=*Salmo gairdneri*).
SEE SECTION 16.9.

14B Relatively few large round dark spots confined to above the lateral line and on a pale background; sides and belly yellow to rosy-red; parr marks usually present in adults; distinct orange or white tip on the dorsal fin; confined in Alberta to high altitude lakes.....**Golden trout—*Oncorhynchus aguabonita* (=*Salmo aguabonita*)**.
SEE SECTION 16.10.

16.1 Cisco (or Tullibee) *Coregonus artedi* Lesueur

[*Core gonus:* a name used by Artedi for European whitefish, meaning the pupil of the eye, angle; *artedi:* named for P. Artedi, ichthyologist associate of Linnaeus]

Cisco from Utikuma Lake. M.J. Paetz.

Description

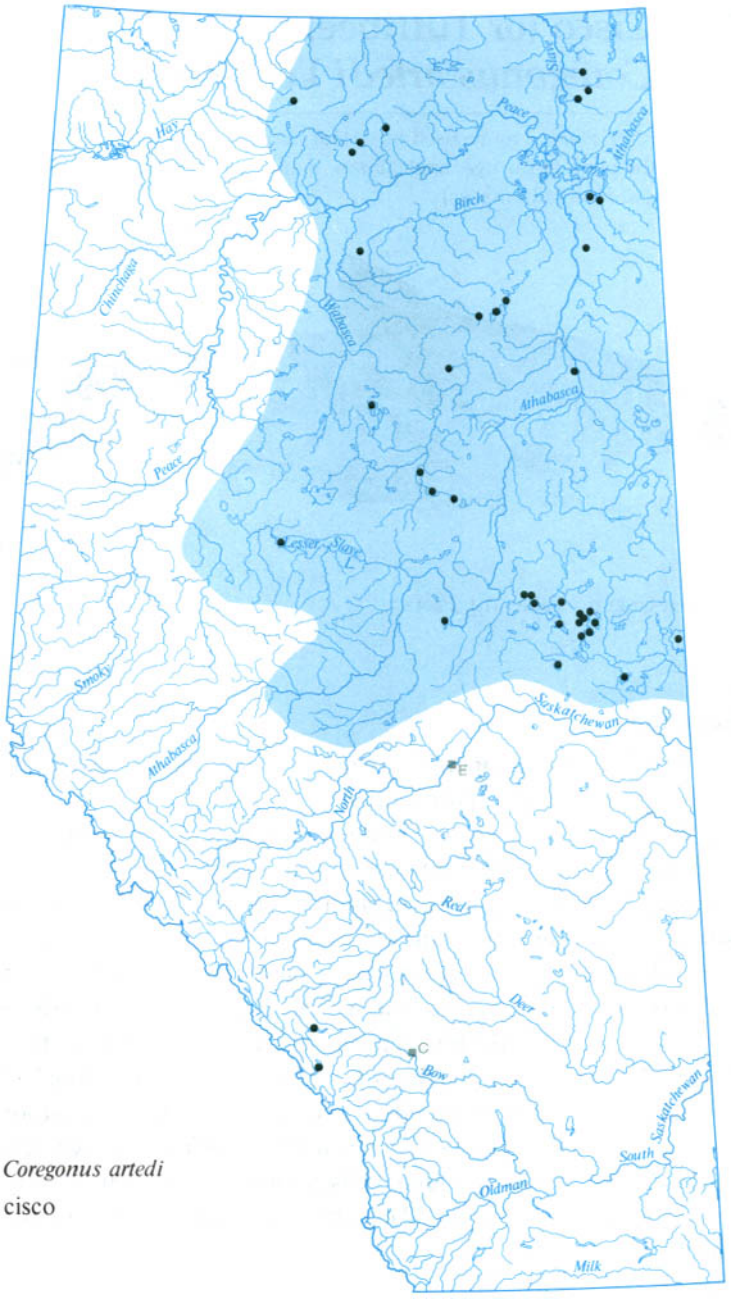
Color: Steel blue with emerald-green overcast dorsally, silvery ventrally. Young without parr marks.

Body: Mouth terminal. Anterior edge of upper jaw directed forward and slightly downward (antrorse); snout sharp. Upper jaw extending beyond front margin of eye, often to midline of eye. Minute teeth sometimes present on premaxillae and tongue; no teeth on maxillae and lower jaw. Two conspicuous nasal flaps between the nostrils on each side as in the lake whitefish (see Fig. 16b). Adipose eyelids present. Caudal fin deeply forked. Length of base of adipose fin much shorter than height of fin. Scales along lateral line 75-90 (not all of these scales are pored); above lateral line about 7-10; around caudal peduncle about 19-25. Dorsal and anal fin rays each about 10-14. Gillrakers on first arch 40-54. Pyloric caeca about 90-150.

Size: Maximum length about 50 cm and weight about 1.4 kg (usually much less).

Alberta

The vertebral number in 18 specimens from Darwin Lake, Alberta, is 55-60. Maximum length noted in Alberta is 41.5 cm fork length (38.7



Map 16.1 Distribution of cisco in Alberta.

cm standard length and weighing 1.044 kg), angled by Ron Hook from Moose Lake in April 1972.

Distribution

● Alberta and Northwest Territories to Quebec and Great Lakes region, south to Wabash River drainage in northern Indiana. Cisco enter salt water in parts of their northern range.

■ Known in Alberta from Slave, Peace, Athabasca, and Beaver river drainages (see Map 16.1); introduced into Spray Lakes Reservoir, east of Banff, in Bow River drainage (see below). Cisco were also successfully stocked in Lake Minnewanka in Banff National Park in 1916 and 1917 (Ward 1974).

Biology

Cisco tend to be pelagic and prefer the cooler depths of lakes where there is plentiful oxygen. Young and adults feed on open water plankton and occasionally on small fishes, including young ninespine stickleback (Roberts 1975b). They generally spawn from late October to December at about 5°C to 2°C in lakes over a wide variety of substrates and depths. Maturity is reached by about age 3 and an average female produces about 10,000 to 25,000 eggs each year. Hatching occurs about April or May. Cisco live to at least 11 years in age in their natural range. There is evidence that they live much longer where their growth is slow such as in Spray Lakes Reservoir. Cisco were introduced into this reservoir in 1953, and individuals caught in 1989 were as old as 31 years. These old fish were probably offspring of the first year class to reproduce, doing so in the fall of 1957. Spawning was apparently successful over the next few years with the 1961 year class being strongest, but since 1966 there has been virtually no reproduction and the youngest known cisco in the reservoir in 1989 was of age 9 (J.D. Stelfox, personal communication, 1991). Cisco hybridize with lake whitefish throughout much of their common range including in several Alberta lakes (Paetz 1972). Cisco form a valuable source of food for mink ranches in the Lesser Slave Lake to Lac La Biche area.

Cisco are the most frequently infected hosts of the final larval stage of the tapeworm *Triaenophorus crassus* (see Section 16.3 on lake whitefish for greater discussion). Cisco are also susceptible to small copepod parasites of the genus *Ergasilus* which attach to the gills. Heavy infections with *Ergasilus*, plus reduced oxygen concentrations due to

algal blooms, can lead to high mortality. Roundworms of the genus *Cystidicola* are sometimes found on the cut surfaces of the fish after cleaning. These parasites live in the swim bladder of cisco and other coregonines, from which they are accidentally dragged onto the meat during cleaning. The roundworm *Philonema*, occurring in the body cavity, can cause degeneration of the gonads. These parasites are harmless to people.

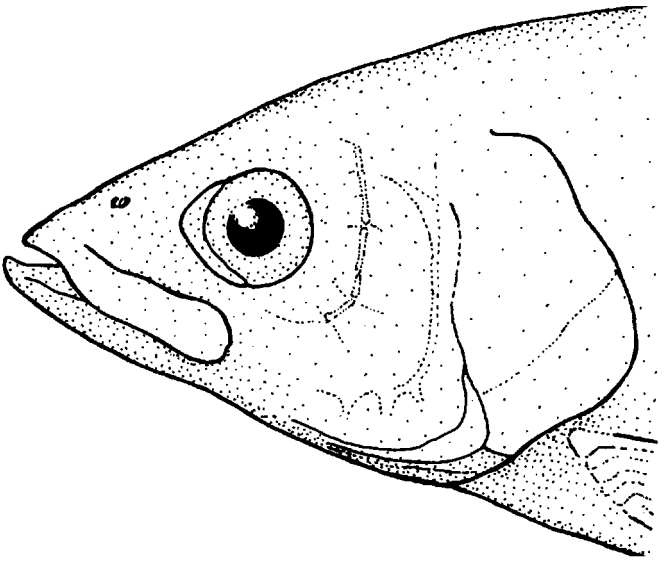
Historical Note

C.A. Lesueur first described the cisco in 1818 from Lake Erie and Niagara River as *Coregonus artedi*. This species bears a close relationship with *Coregonus albula* and C. *sardinella*. In Alberta, Kendall (1924) noted the cisco in Lake Athabasca as *Leucichthys athabascae* and in Lac La Biche as *L. tullibee*. Dymond and Pritchard (1930) noted it from Lesser Slave Lake, nearby Fawcett Lake, and Lake Athabasca as *L. tullibee*. The specific name of this species has for the last several decades generally been spelt *artedii*, as given in Robins et al. (1980). However, as noted in Bailey and Robins (1988:98) and Robins et al. (1991), the current rules of zoological nomenclature require that it be spelt *artedi*; it is possible that the Commission of Zoological Nomenclature will conserve the commonly used spelling *artedii*.

The taxonomic status of species of ciscoes in Alberta is poorly known and more work needs to be done.

16.2 Shortjaw Cisco *Coregonus zenithicus* (Jordan and Evermann)

[*Core gonus:* a name used by Artedi for European whitefish, meaning the pupil of the eye, angle; *zenithicus:* in reference to Duluth, "the Zenith City," where specimens were seen]



Head of shortjaw cisco from Barrow Lake, 27.5 cm standard length.

Description

Generally similar to *Coregonus artedi*. Distinguished from other species of cisco by the following combination of characters: gillrakers 32-46, usually 38-42 (37-41 reported from Alberta versus 44-51 in *C. artedi* from the same lake); lower jaw usually very slightly projecting beyond upper jaw (the opposite relationship to that found in Alberta is shown in some books); body deepest at center, not deepest in front part as in *C. nigripinnis* (see Appendix I for further mention of this species).

Distribution

● Great Lakes Basin, presently in lakes Superior and Nipigon. This species is reported to occur elsewhere, such as in the Northwest Territories

and in Alberta, but more detailed taxonomic work is needed to have confidence in identifying cisco outside the Great Lakes area as *C. zenithicus*.

■ Recognized in Alberta from Barrow Lake (north of Fort Chipewyan in Slave River drainage); further work will probably show it to be present in other lakes of the McKenzie lowlands. It was tentatively identified in Gregoire Lake, south of Fort McMurray, by Tripp and Tsui (1980) from 16 specimens having 38-41 gillrakers.

Biology

The biology of the shortjaw cisco is probably similar to that of *C. artedi*. In Barrow Lake, Paterson (1969) reported specimens from 28 to 47 cm fork length being captured in about 2-4 m of water (in contrast, the individuals of *C. artedi* were all much smaller and younger and at depths greater than 14 m). It is of interest to note that *C. zenithicus* in other areas is reported to be smaller than *C. artedi* and that its size in Barrow Lake exceeds the maximum size reported elsewhere. For more information on shortjaw cisco see Houston (1988).

Historical Note

D.S. Jordan and W.B. Evermann first described the shortjaw cisco in 1909 from Lake Superior as *Argyrosomus zenithicus*. It was first reported in Alberta in the western portion of Lake Athabasca by Dymond and Pritchard (1930), but the first verifiable record was made by Paterson (1969) in Barrow Lake.

The Alberta population seems to superficially resemble the longjaw cisco, *Coregonus alpenae*, a form thought to be conspecific with *C. zenithicus*, and more taxonomic work needs to be done on it. All that we can be reasonably certain of is that there are at least two species of cisco in Alberta (based on the sympatric occurrence of two forms in Barrow Lake).

16.3 Lake Whitefish *Coregonus clupeaformis* (Mitchill)

[*Core gonus:* a name used by Artedi for European whitefish, meaning the pupil of the eye, angle; *clupea formis:* herring shape]

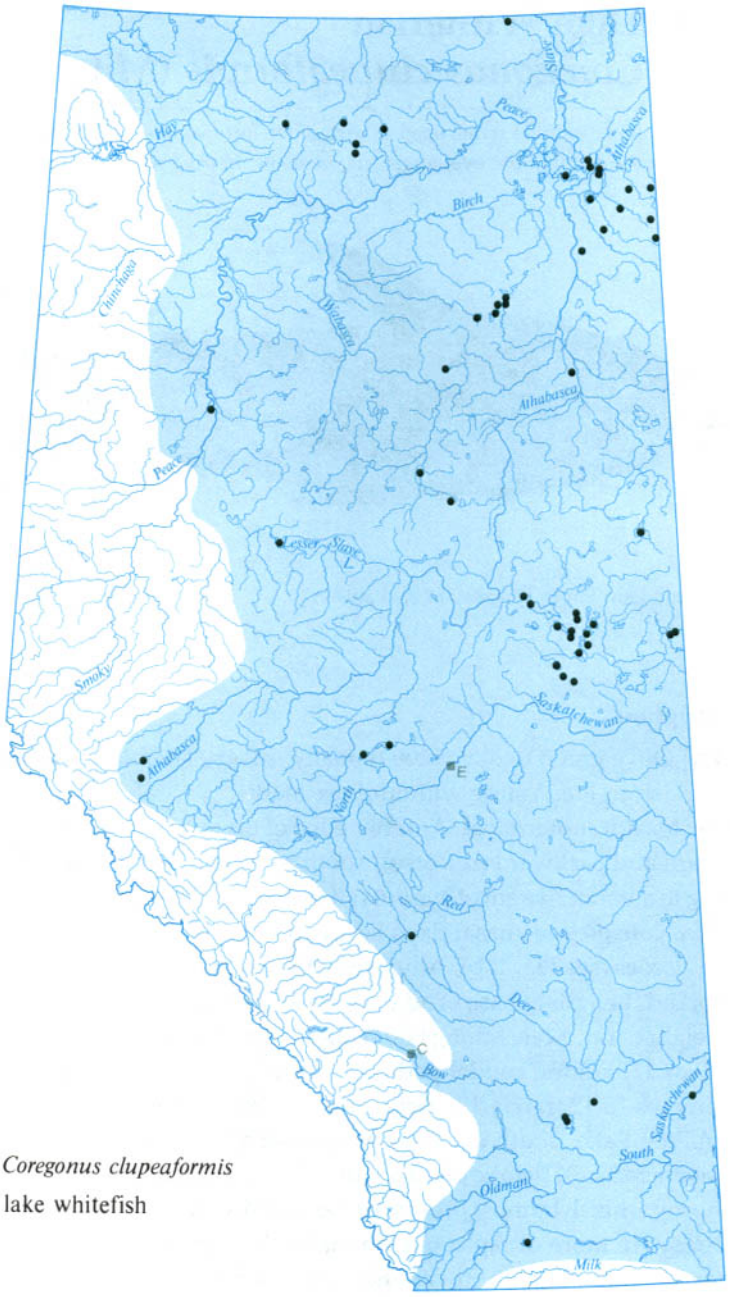
Lake whitefish. Photo courtesy of A. Paulsen.

Description

Color: Olive green to olive blue dorsally, silvery laterally; fins partly darkish in life. Young without parr marks.

Body: Mouth subterminal. Anterior edge of upper jaw directed downward and backward (retrorse); snout rounded. Upper jaw extending to anterior margin of eye but not to midline. Teeth inconspicuous. Two conspicuous nasal flaps between the nostrils on each side as in ciscoes (see Fig. 16b). Adipose eyelid present. Caudal fin deeply forked. Length of base of adipose fin about equal to or greater than height of fin. Scales along lateral line 77-95; above lateral line about 10 or 11; around caudal peduncle about 22 or 23. Dorsal and anal fin rays 10-12 (rarely 13). Gillrakers on first arch usually 23-33, but in Frog Lake, south of Cold Lake, Alberta, they range from 28-37 (average 32.6). Pyloric caeca about 150-200. Nuptial tubercles (small horny whitish bumps) present on head and scales at spawning time, these are more conspicuous on males than on females.

Size: Maximum length 91 cm and weight 6.8 kg.



Map 16.3 Distribution of lake whitefish in Alberta.

Alberta

Vertebral number in 26 specimens from Lac St.Anne is 54-63.

The maximum length observed in Alberta is 63 cm fork length (and weighing 8.7 kg) in a specimen taken from Lesser Slave Lake in 1936.

Distribution

● Alaska to Labrador and northern half of British Columbia to New Brunswick with southern limits in lakes Michigan and Erie. Introduced within and outside native range, including southern British Columbia. Lake Whitefish enter salt water in parts of their northern range.
■ Known in Alberta from Petitot, Hay, Slave, Peace, Athabasca, Beaver, North Saskatchewan, upper Battle, lower Red Deer (up to the vicinity of the Dickson Dam and the lowermost reaches of the Medicine River), South Saskatchewan, lower Bow, and Oldman river drainages; most populations in the latter four drainages may not be native (there undoubtedly is a certain amount of dispersal through irrigation canals and streams within these drainages, following historical introductions into irrigation reservoirs). Lake whitefish are probably native to Waterton Lake (see Map 16.3). Introduced into many lakes and reservoirs in south-central Alberta. The introduction into Lake Minnewanka, Banff National Park, in the 1950s was with mixed success (Ward 1974); this site may have been the source of lake whitefish occurring downstream in Ghost Reservoir.

Biology

Lake whitefish are generally restricted to the cool well-oxygenated regions of lakes, usually near the bottom, but they are occasionally pelagic. In Alberta, they occasionally occur in rivers. They feed primarily on bottom organisms, notably chironomid (midge) larvae, clams, and snails and secondarily on amphipods, other insect larva, and zooplankton (Bidgood 1973; Ash 1974). Surprisingly, considering the shape and small size of the mouth, lake whitefish and other species of whitefish may occasionally eat fishes. In what is probably an exceptional example of piscivory for this species, M.G. Sullivan (personal communication) in January 1990 found two 45 cm fork length (FL) lake whitefish in the Calling Lake fish packing plant that had been feeding on yellow perch; one whitefish had a 12 cm FL perch in its mouth and the other had a 15 cm FL perch (a tight fit!). The plant manager reported seeing

many whitefish with perch in their stomachs that year. In Cold Lake, lake whitefish were noted by Roberts (1975b) to feed on adult ninespine stickleback as large as 6.3 cm FL, especially in June.

Lake whitefish spawn over firm substrates in depths of 2-4 m from late September to January with an average egg production of about 18,000 eggs per kilogram of fish. There is a very wide range in fecundity of whitefish from different lakes (Bidgood 1974; Healey and Dietz 1984). As is perhaps true for most Alberta fish, only about 10% of fertilized eggs survive to become fry. Most lake whitefish mature by age 6 or 7; males mature at a younger average age than females. The maximum age of lake whitefish in most lakes is about 10 years.

Lake whitefish are the mainstay of a valuable commercial fishery in Alberta. For example, in Lake Wabamun, west of Edmonton, up to 270,000 kg of whitefish have been taken in one year. Commercial fishing is done with gillnets. The size of the mesh is specified by Fish and Wildlife so that only fairly large fish are caught. One probable consequence of this is that it selects against the fast growing fish because they are removed from the population at a younger age than are slow growing fish. The influence of this selection on the characteristics of the Lesser Slave Lake population and its life-history parameters is given by Bell et al. (1977) and Handford et al. (1977). In the past, many lakes fished commercially had their whitefish populations supplemented with "eyed-eggs" from whitefish hatcheries. Natural reproduction, however, provides more fish than can survive and the hatchery operations did little or nothing to increase a population. This species also provides an important sport fishery during the winter months when many people enjoy "ice fishing."

Lake whitefish hybridize with cisco in parts of their area of common range including in several Alberta lakes (Paetz 1972). Hybrids were found to be most abundant in Utikuma Lake where presumed first generation hybrids made up 6% of the combined population. Hybrids may be readily identified by their intermediate characteristics (e.g., gill-raker number of about 33-43 and of intermediate length; a blunt snout with the premaxillae about vertical).

Lake whitefish, along with cisco and occasionally other salmonids, carry the final larval stage of the tapeworm *Triaenophorus crassus* (Miller 1952a). Such fish are said to be "wormy," but the condition is harmless to humans although the fish are not appetizing to most people and excessively "wormy" fish can not be exported. The parasite is picked up by ingestion of its first larval host, the copepod *Diacyclops* (=*Cyclops*)

bicuspidatus *thomasi*, in July or August. A tapeworm larvae burrows its way out of the fish's stomach, moves into muscle tissue for 2 to 3 months, and forms a cyst, which may persist for several years. If the fish is eaten by a northern pike, the parasite matures to an adult tapeworm and releases eggs into the water. The eggs hatch to a free-swimming form which may then be eaten by *Diacyclops bicuspidatus*. The cysts in whitefish tend to be concentrated in the muscle of the dorsal half of the fish between the head and dorsal fin; slightly higher concentrations appear on the right side than on the left side. Larval cysts in whitefish cause more of an economic loss than those in cisco, but those in cisco usually are more important in carrying on the life cycle. *Triaenophorus crassus* is rarely found in lakes devoid of cisco (hence, lake whitefish in lakes south of Highway 16 are not "wormy"). Attempts to control the infections in whitefish by reducing cisco populations have been partly successful. Whitefish are also susceptible to *Cystidicola*, a roundworm in the swim bladder and to the larvae of a species of *Diphyllobothrium* (not *D.* (=*Dibothriocephalus*) *latum*, and probably not infectious to humans), which occurs on the stomach wall. For more information on the wide variety of parasites that may be in lake whitefish in Alberta see Drouin (1982), Leong (1975), and Leong and Holmes (1981).

Dr. R.B. Miller was a pioneer in conducting many studies on lake whitefish in Alberta (see References).

Angling

Lake whitefish angling has really only achieved significance in Alberta within the last two decades or so, in a limited number of lakes and in some rivers. Wabamun Lake, Pigeon Lake, and Lac Ste. Anne near Edmonton yield good returns, but other lakes such as Muriel, McGregor, and Buck have also become popular. The majority of lake whitefish taken by anglers are caught in late fall and throughout the winter. Weighted flies are commonly used in open water fishing, and jigging a variety of very small lures with a short stiff casting rod or with a hand line are the favorite techniques of ice fishermen. Because of its general abundance throughout the province, this fish is becoming one of the mainstays of the winter sport fishery.

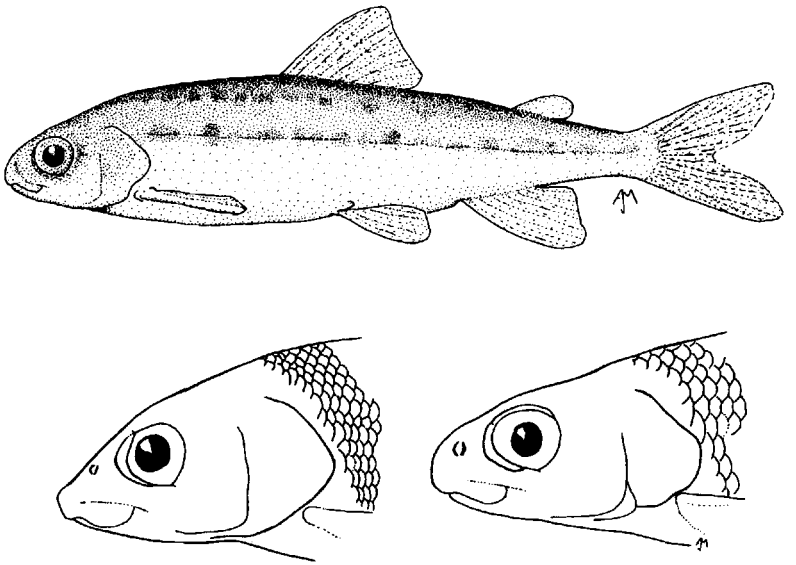
Historical Note

S.L. Mitchill first described the lake whitefish in 1818 from Sault Ste. Marie as *Salmo clupeiformis*. It was reported in Lake Wabamun and "many lakes of northern Alberta" by Whitehouse (1919) as *Coregonus*

labradoricus. Kendall (1924) noted them in Lake Athabasca and the Athabasca River above the Embarras River. It was identified from Beauvert Lake, near Jasper, by Bajkov (1927) as *Coregonus nasus* (see Dymond 1943:192, for a discussion on this designation), but it is possible that the locality is erroneous. The Soviet ichthyologist Leo Berg, on the basis of Bajkov's description, established the subspecies *C. nasus canadensis* for the Jasper form.

16.4 Pygmy Whitefish *Prosopium coulteri* (Eigenmann and Eigenmann)

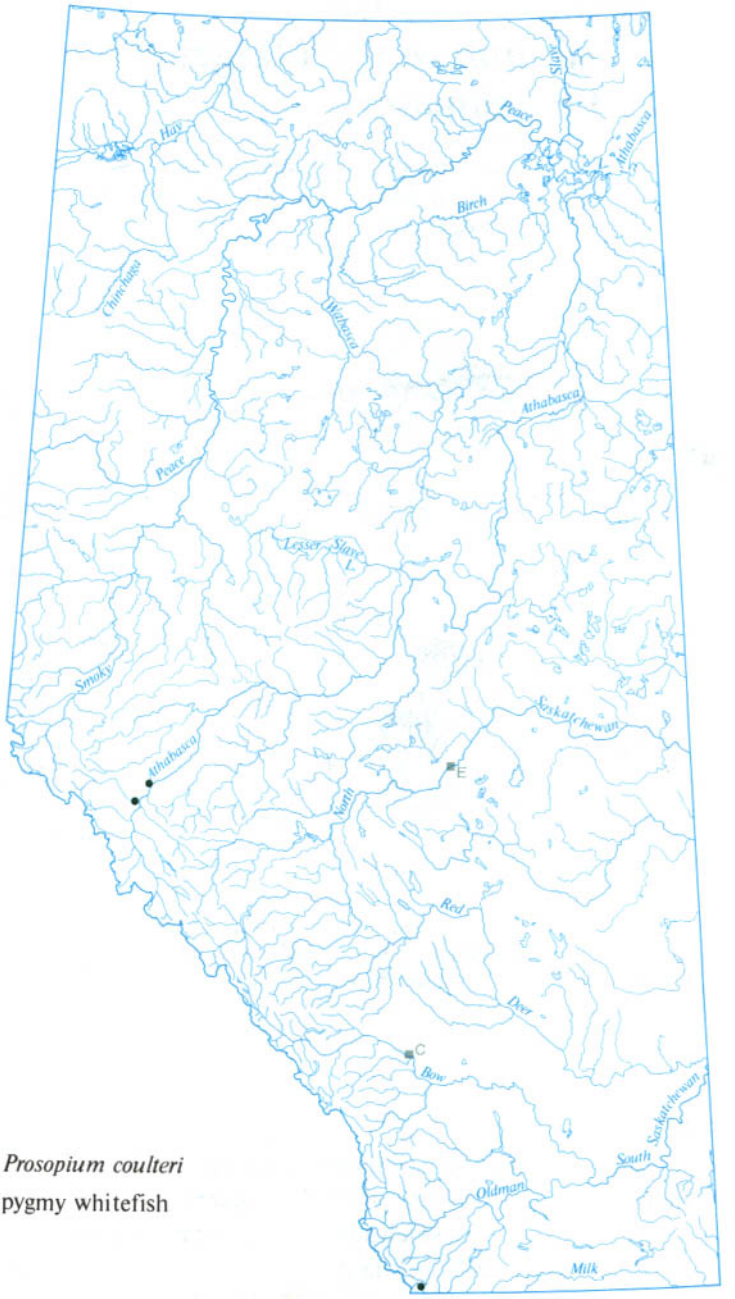
[*Prosopium:* a mask, from the large bones in front of the eyes; *coulteri:* after Rev. J.M. Coulter, author of the "Manual of the Botany of the Rocky Mountain Region"]



Pygmy whitefish from Solomon Creek, 11.1 cm standard length. Lower diagrams show head region of mountain whitefish (left) and pygmy whitefish (right), both specimens 11.1 cm standard length to show difference in relative size of the eye and scales and in snout shape.

Description

Generally similar to mountain whitefish (*Prosopium williamsoni*). Distinguished from other *Prosopium* by the following combination of characters: snout bluntly rounded; small adipose fin, its base usually smaller than eye diameter; scales relatively large; 50-70 pored scales along lateral line; scale rows around caudal peduncle 15-20; gillrakers on first arch 12-21; pyloric caecae 13-33; vertebrae 50-55; no spots on adipose fin or on top of head.



Map 16.4 Distribution of pygmy whitefish in Alberta.

Maximum length about 27 cm, but in most lakes and streams throughout the range of this species its maximum length is under 14 cm.

This species may be confused with small mountain whitefish. Every effort should be made to distinguish these two species in order to accurately document the Alberta distribution of pygmy whitefish.

Distribution

● Alaska to Montana, primarily in mountainous regions, and in Lake Superior.

■ Known in Alberta from Waterton Lakes (Lindsey and Franzin 1972) and Solomon Creek (west of Hinton near the Athabasca River—UAMZ 5277) (see Map 16.4). There are additional reports of pygmy whitefish collected in October 1980 from the lower reaches of Snake Indian River in the Athabasca River drainage within Jasper National Park; this is just east of the divide from Yellowhead Lake in the upper Fraser River drainage where the species also occurs (D.W. Mayhood, personal communication) and from the Saskatchewan portion of Lake Athabasca (P.J. McCart, D.W. Mayhood, and D. Tripp, personal communication).

Representing an apparent range extension, two pygmy whitefish were identified by W.E. Roberts at the University of Alberta Museum of Zoology from a collection made by C.D. Tebby in 1974 from Echo Bay, Great Bear Lake (UAMZ 3537).

Biology

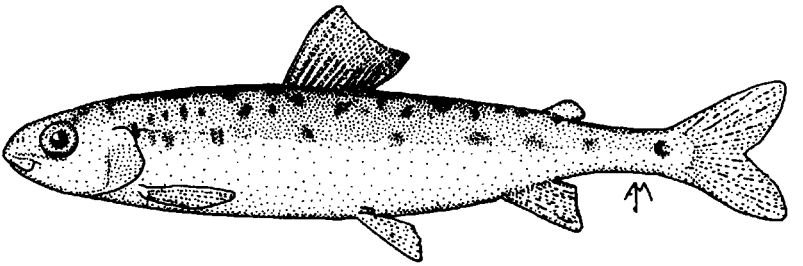
Virtually nothing is known of the biology of this species in Alberta. In British Columbia, where it has most commonly been found in lakes in relatively deep water, it is thought to spawn from October to December. Feeding occurs primarily on bottom organisms such as insect larvae and crustaceans.

Historical Note

Carl H. Eigenmann and his wife Rosa S. Eigenmann first described the pygmy whitefish in 1892 as *Coregonus coulterii* from the Kickinghorse River at Field, British Columbia (collections made by C.H. Eigenmann from Indiana along the Canadian Pacific Railroad route). It was first noted in Alberta by Lindsey and Franzin (1972) from Upper Waterton Lake on the basis of two specimens gillnetted from about 50 m depth on 10 August 1971. The Solomon Creek specimen referred to above was collected in 1966 but not identified until 1984.

16.5 Round Whitefish *Prosopium cylindraceum* (Pallas)

[*Prosopium:* a mask, from the large bones in front of the eyes; *cylindraceum:* like a cylinder]



Round whitefish, Wolf Creek, Great Slave Lake, Northwest Territories, 10 cm standard length.

Description

Generally similar to mountain whitefish (*Prosopium williamsoni*). Distinguished from other *Prosopium* by the following combination of characters: body rounded in cross section; snout pointed, relatively compressed laterally; small adipose fin, its base length about equal to eye diameter in large specimens and less than 1 1/2 times eye diameter in small specimens; pored scales in lateral line 74-108; scale rows around caudal peduncle 24-27; gillrakers on first arch 14-21; pyloric caecae 61-130; vertebrae 58-65; black or brown spots usually on head and adipose fin.

Maximum length 51 cm.

Distribution

● Siberia and in North America from Alaska to Labrador and south to northernmost British Columbia and Great Lakes Basin.

■ Known in Alberta only from the Peace-Athabasca Delta.

Biology

Round whitefish inhabit lakes and rivers and spawn in the fall. One Alberta specimen of 33.6 cm fork length was estimated to be 8 years old. The species is known to feed on insect larvae, small snails, crustaceans, and eggs of other fish species.

Historical Note

P.S. Pallas first described the round whitefish in 1784 from certain rivers in Siberia as *Salmo Cylindraceus*. It was generally known in North America until the 1940s as *Prosopium quadrilaterale*. The round whitefish was previously thought to occur in Alberta because of records from the Saskatchewan portion of Lake Athabasca. However, it was first recorded in Alberta by Kristensen and Foy (1980) from two specimens captured in 1977 from Little Rapids on the Rivière des Rochers adjacent to Wood Buffalo National Park in the Peace-Athabasca Delta (one specimen was saved—UAMZ 3779).

16.6 Mountain Whitefish *Prosopium williamsoni* (Girard)

[*Prosopium:* a mask, from the large bones in front of the eyes; *williamsoni:* named for Lt. R.S. Williamson, of the U.S. Pacific Railroad exploration.]

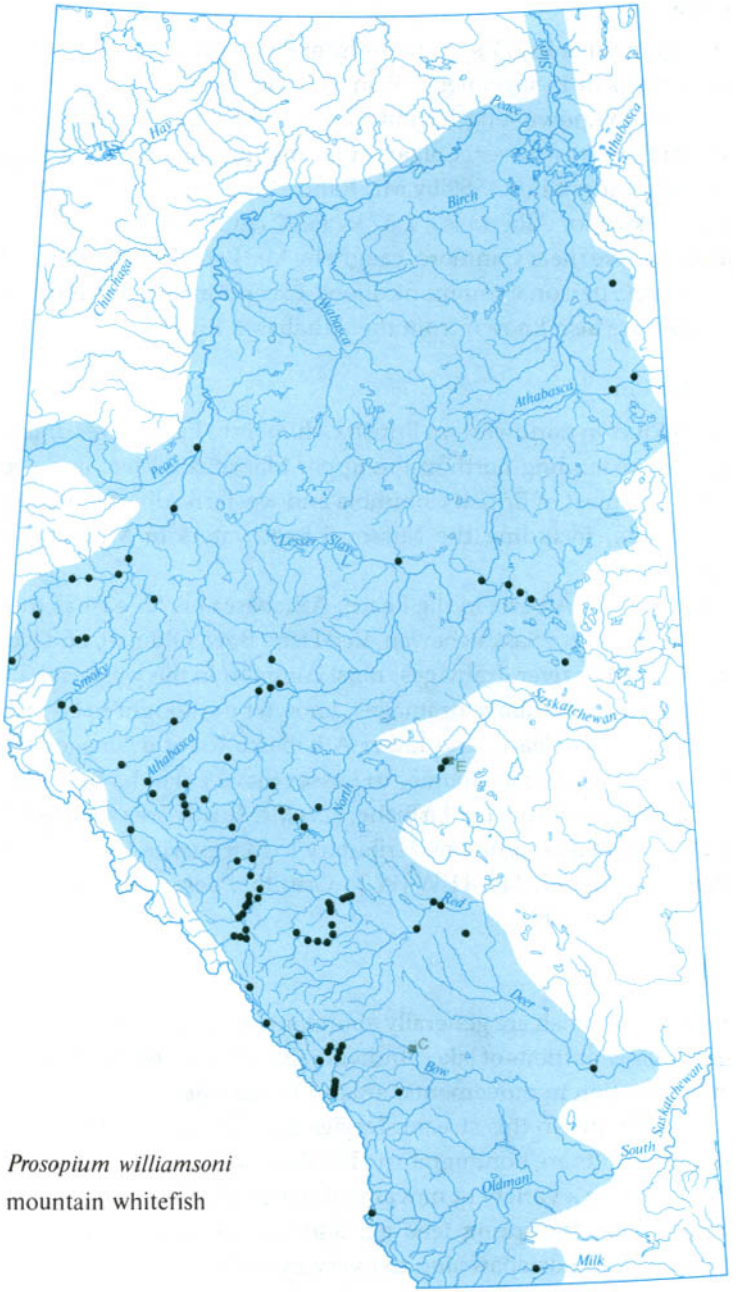
Mountain whitefish from North Saskatchewan River. M.J. Paetz.

Description

Color: Grayish-blue to light brown dorsally, silvery laterally. Young with 8-11 roundish parr marks along the lateral line and a few spots above.

Body: Mouth subterminal and snout somewhat pointed (bulbous in some mature specimens, especially in the fall and winter; W.E. Roberts, personal communication). Upper jaw usually extending to anterior margin of eye but never reaching to midline. Teeth inconspicuous. One flap separating the two closely spaced nostril openings on each side of head as in all other Alberta salmonids except Arctic grayling, cisco, shortjaw cisco, and lake whitefish (see Fig. 16b). Caudal peduncle relatively narrow compared to other salmonids (about equal to base length of the long adipose fin). Caudal fin deeply forked. Scales along lateral line 74-92; above lateral line 8-11; around caudal peduncle 19-24. Dorsal fin with 11-14 rays and anal fin with 10-13 rays. Gillrakers on first arch 19-26. Pyloric caeca usually 60-140.

Size: Maximum length may be 58.5 cm (from the following noted Alberta record).



Map 16.6 Distribution of mountain whitefish in Alberta.

Alberta

Vertebral number in 177 specimens from Peace River to Oldman River drainages: 57 in 15 specimens, 58 in 69, 59 in 69, 60 in 22, and 61 in 2.

Maximum known length from Alberta is 58.5 cm fork length (2.44 kg) from the Elbow River, Calgary; this angling record was an 18 year old female caught July 1989 by Mr. Randy Woo (Scammell 1990). The weight record for Alberta is a 2.57 kg (55.2 cm fork length) specimen from Gap Lake, near Canmore, caught by Mr. Peter Zebroff, June 1991 (J.D. Stelfox, personal communication). Exceptionally large mountain whitefish are also known from the Athabasca River.

Distribution

● Taku River in northwestern British Columbia to Peace River drainage in Alberta extending north in the upper Mackenzie River and south throughout most of British Columbia and western Alberta to Oregon and Nevada, including the Missouri headwaters in Montana and Wyoming.

■ Known from Alberta in the Peace, Athabasca (as far east as the La Biche River), North Saskatchewan, Red Deer, Bow, Oldman, and North Fork of the Milk river drainages; most common in the western half of the province in the above drainages, known but thought to be rare in the Slave, lower Peace, and lower Athabasca River drainages (e.g., Swan River which is a tributary to Lesser Slave Lake; La Biche River and one specimen from Lac La Biche; Fort McMurray area such as High Hill River; and in an unnamed tributary to Marguerite River (Firebag system) at 57°36'N, 110°41'W (W.E. Griffiths, personal communication) (see Map 16.6).

Biology

Mountain whitefish are generally abundant in streams and in the relatively shallow portions of lakes. Individuals in the same area can exhibit a wide variation in movements, at least in the Sheep River of southwestern Alberta. In this stream, Davies and Thompson (1976) found that some adults are nonmigratory, but that most are migratory; of the latter, there are a variety of movement patterns such as migrations to different areas for spring feeding, summer feeding, prespawning, spawning, and postspawning to overwintering.

Bottom fauna are the main food of mountain whitefish; small drifting animals are a major food item in streams and terrestrial insects are

occasionally eaten in substantial quantities. McHugh (1940) and Thompson and Davies (1976) found that benthic aquatic insect larvae were the primary item in the diet of mountain whitefish in the Bow River drainage.

Small tubercles, more pronounced in males than in females, may develop on the lateral scales prior to spawning time. Spawning occurs from late September to early November over gravel shallows in lakes or over gravel in streams. Unlike trout, no redd or nest is built. Females lay an average of about 2,000-8,000 eggs (more in exceptionally large fish). The eggs hatch between March and late April, at about the time when ice breakup is occurring on the rivers (Roberts 1988a). The young form schools and tend not to hide under rocks as do most other stream salmonids; they thus may not compete for space with young brown trout. Maturity is generally reached at ages 3-5. McHugh (1941), Thompson and Davies (1976), Dietz (1971), and Tebby (1974) noted their growth from the Bow, McLeod, and North Saskatchewan River drainages; they report ages up to 18 years. The maximum age recorded in Alberta is 29 years for a fish from Spray Lakes Reservoir, determined from otoliths (J.D. Stelfox, personal communication). Mountain whitefish have been found with the tapeworm *Triaenophorus crassus* in Lesser Slave Lake (Miller 1945a). They are commonly infected with the swim bladder nematode, *Cystidicola*, and occasionally with a large copepod (*Coregonicola*) on the gills.

Angling

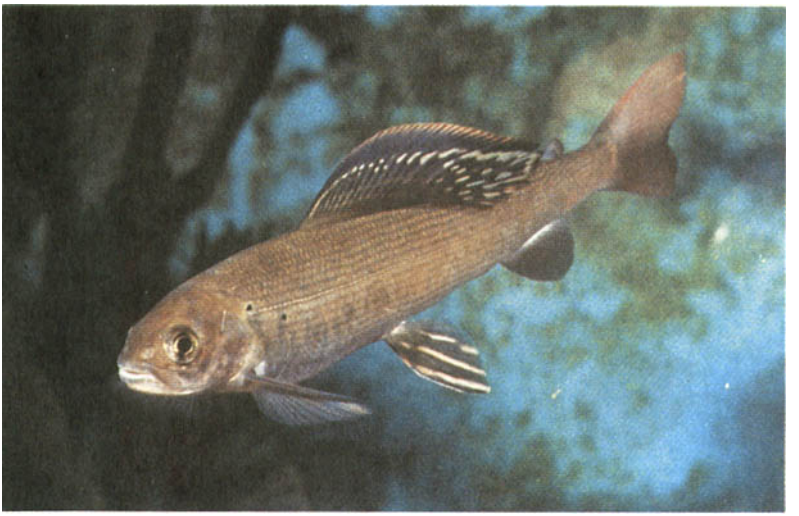
Mountain whitefish contribute substantially to the angler harvest from eastern slope streams of Alberta. They are common in medium and large, clear, cold rivers and are readily available to the angler throughout the open water season, but are particularly abundant in early fall when they form large schools in some rivers. Since most of the fish caught are less than half a kilogram in weight, they provide the best sport on a fly rod using flies in sizes varying from No.6 to No.22. Wet flies are usually most successful since these fish forage chiefly along the bottom of the stream. Small spinning lures will also take mountain whitefish, but the most widely used method of angling is drifting natural baits such as stoneflies or maggots along the stream bottom. This species supports an attractive winter fishery in areas of larger rivers that remain ice free such as the Bow River from Banff to Cochrane. No commercial fishery exists for mountain whitefish.

Historical Note

C.F. Girard first described the mountain whitefish in 1856 from Des Chutes River, Oregon, as *Coregonus williamsoni*. It was first noted in Alberta by Eigenmann (1895) from the Bow River at Calgary and Banff. However, its presence was alluded to in a 1892 publication of the Eigenmanns where, in the description of the pygmy whitefish, they state that mountain whitefish were found east of Field in a tributary of the Saskatchewan (they were no doubt referring to the Bow River, a tributary of the South Saskatchewan River). Vick (1913) noted it to be widespread in the Banff area (e.g., Boom, Moraine, and Spray lakes) and in Lower Kananaskis Lake (which may be erroneous since it was not present in surveys conducted from 1938 onward). Whitehouse (1919) noted reports of the species from west of Red Deer in the Raven and Clearwater rivers. Dymond (1943) described six specimens and Miller (1945a) noted the species from Lesser Slave Lake as *Prosopium oregonium*. In southwestern Alberta mountain whitefish are often called "grayling," a name which causes some confusion with the Arctic grayling.

16.7 Arctic Grayling *Thymallus arcticus* (Pallas)

[*Thymallus:* an ancient name of the grayling, pertaining to the fish's supposed odor of thyme (the origin of this belief is uncertain); *arcticus:* of the arctic]

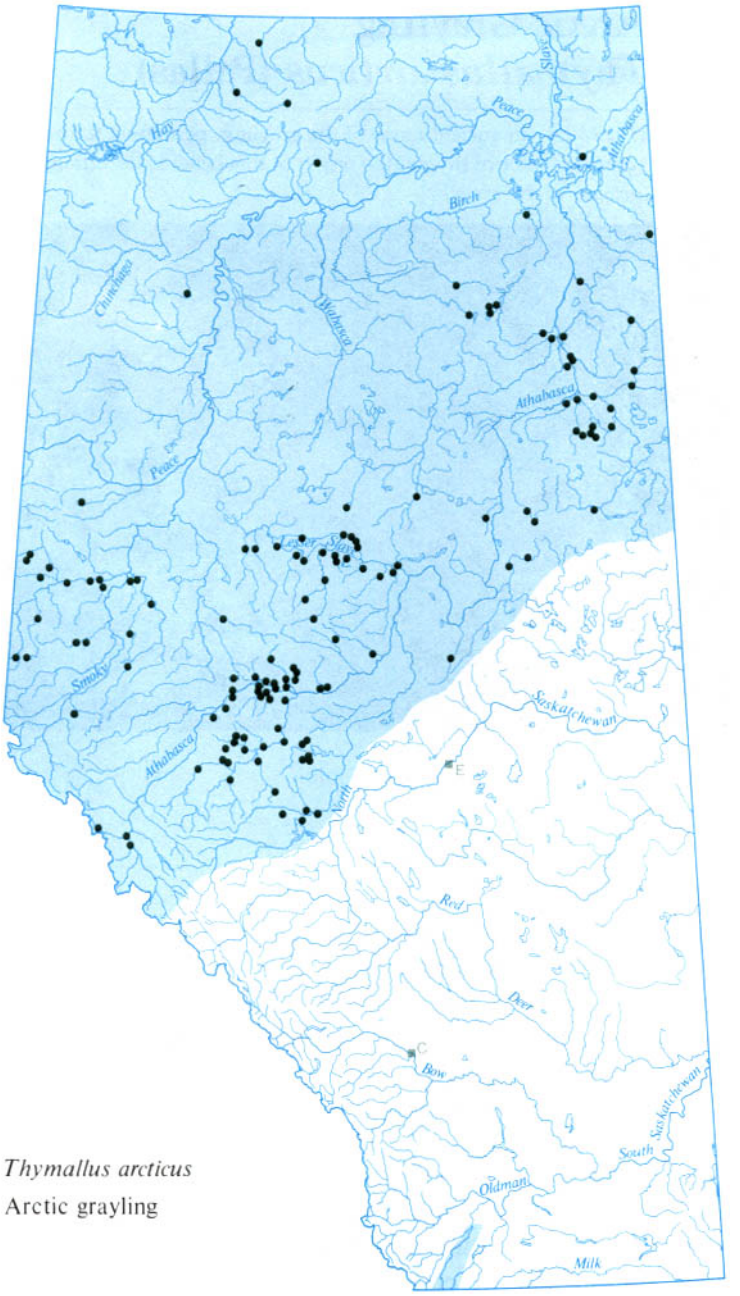


Arctic grayling. Photo courtesy of C.A. Gordon.

Description

Color: Dark bluish dorsally, iridescent greenish-gray or bronzy laterally. Black spots on adults, commonest on anterior half above the lateral line. Black "hyoid" spots in folds of the lower jaw in life. Dorsal and pelvic fins colored, especially brilliant in spawning males which also have a dark body. Young with 12-16 elongated dark brown parr marks crossing the lateral line, above which are several irregular rows of dark marks.

Body: Upper jaw extending behind anterior margin of eye, almost to middle of eye. Teeth small, present on jaws, head of vomer, palatines, and usually on tongue; wide gap between vomerine and palatine teeth at anterior end. Two nostril openings on each side separated by a distinct gap with only the anterior nostril having a distinct flap. Caudal fin deeply forked. Scales along lateral line 75-100; above lateral line about 9 or 10; around caudal peduncle about



Map 16.7 Distribution of Arctic grayling in Alberta.

24-26. Dorsal fin rays 16-23; anal fin rays 10-12. First arch gillrakers 14-22. Pyloric caeca 13-20. Dorsal fin, and less noticeably the pelvic fin, longer in mature males than in females.

Size: Maximum length 75 cm and weight 2.7 kg.

Alberta

Vertebral number in 57 specimens from the Athabasca River drainage: 58 in 1 specimen, 59 in 6, 60 in 28, 61 in 15, 62 in 5, and 63 in 2.

Maximum known length from Alberta is 35 cm fork length from Marten Creek (Ward 1951) and maximum weight is 1.3 kg from the Embarrass River. Ward (1951:52) also mentions that they reached up to 22 inches (55 cm) in the Beaverlodge River, Wapiti drainage, in the 1930s when there were large harvests by local residents using dipnets.

Distribution

● Ob River in western Soviet Union, St. Lawrence Island and Alaska to northeastern Northwest Territories and northwestern British Columbia (south to Stikine River) through much of the Peace River to Owl River in Manitoba. Native stocks in the Michigan area and Missouri drainage are probably extinct. Introduced within and outside native range.

■ Arctic grayling are known in Alberta from Hay, Peace, and Athabasca river drainages (see Map 16.7). Good populations exist in, for example, the Little Smoky River and some of its tributaries. Specimens have occasionally been taken from the Belly River in the Oldman River drainage. They are stocked in two lakes, Bear Pond and Big Iron Lake, of the Willow Creek system in the Oldman River drainage, but although they have been observed spawning there is no evidence of reproduction (J.D. Stelfox, personal communication).

Biology

Arctic grayling are confined to cool streams and lakes and are extremely susceptible to various forms of pollution. They feed primarily on aquatic and terrestrial insects, secondarily on bottom organisms and plants, and rarely on fish and small mammals such as shrews and voles. Spawning occurs in streams in May and early June at about 5-10°C; at this time the males defend their spawning territories. During mating, the male arches his large dorsal fin over the back of the female

and the pair quiver intensely. The eggs are buried in gravel. An average female produces about 5,000-10,000 eggs annually. Small tubercles have been observed on spawning Arctic grayling in Saskatchewan (they probably occur in Alberta Arctic grayling as well); these knob-like structures on the scales are thought to enable the sexes to maintain contact during spawning (Kratt and Smith 1978). Grayling live for as long as 12 years. Ward (1951), Bishop (1967), Kratt and Smith (1977, 1979), and Carl et al. (1992) present details on the life history of this species.

Angling

Angling for this species in Alberta is for the most part confined to stream fishing since very few lakes in the province contain year round resident populations. Arctic grayling are an easily caught sport fish, and the larger fish are often rapidly depleted even under moderate angling pressure. An excellent fish for the fly fisherman, they may be taken on a wide variety of patterns, both wet and dry. The use of spinning tackle with natural baits or small lures is also a popular method of fishing. The summer period from mid-June to mid-September is the best time for fishing for Arctic grayling, with the period from mid-July to the end of August being the best time for dry fly fishing. Arctic grayling are an excellent table fish.

Historical Note

P.S. Pallas first described Arctic grayling in 1776 from a tributary of the Ob River as *Salmo arcticus*. Preble (1908) reported it present from the Peace River and from Lake Athabasca downstream as *Thymallus signifer*. Kendall (1924) gives a description of specimens from Lake Athabasca. Bajkov (1927) noted it from the Athabasca and Snake (probably the Snake Indian) rivers and from Pyramid Lake in Jasper Park. Bajkov's reports of the species in Jasper National Park may be erroneous; unlike for some other species, he does not give any measurements for Arctic grayling and it is not clear that he had specimens in his possession (there are no recent or verifiable records of it from this park). The term ''grayling'' is often used in southwestern Alberta for mountain whitefish. Fossil remains of Arctic grayling of mid-Wisconsinan age have been recovered from January Cave on Plateau Mountain at the south end of the Highwood Range about 80 km southwest of Calgary (Crossman and McAllister 1986:88; Burns 1991).

16.8 Cutthroat Trout *Oncorhynchus clarki* (Richardson) (= *Salmo clarki* Richardson)

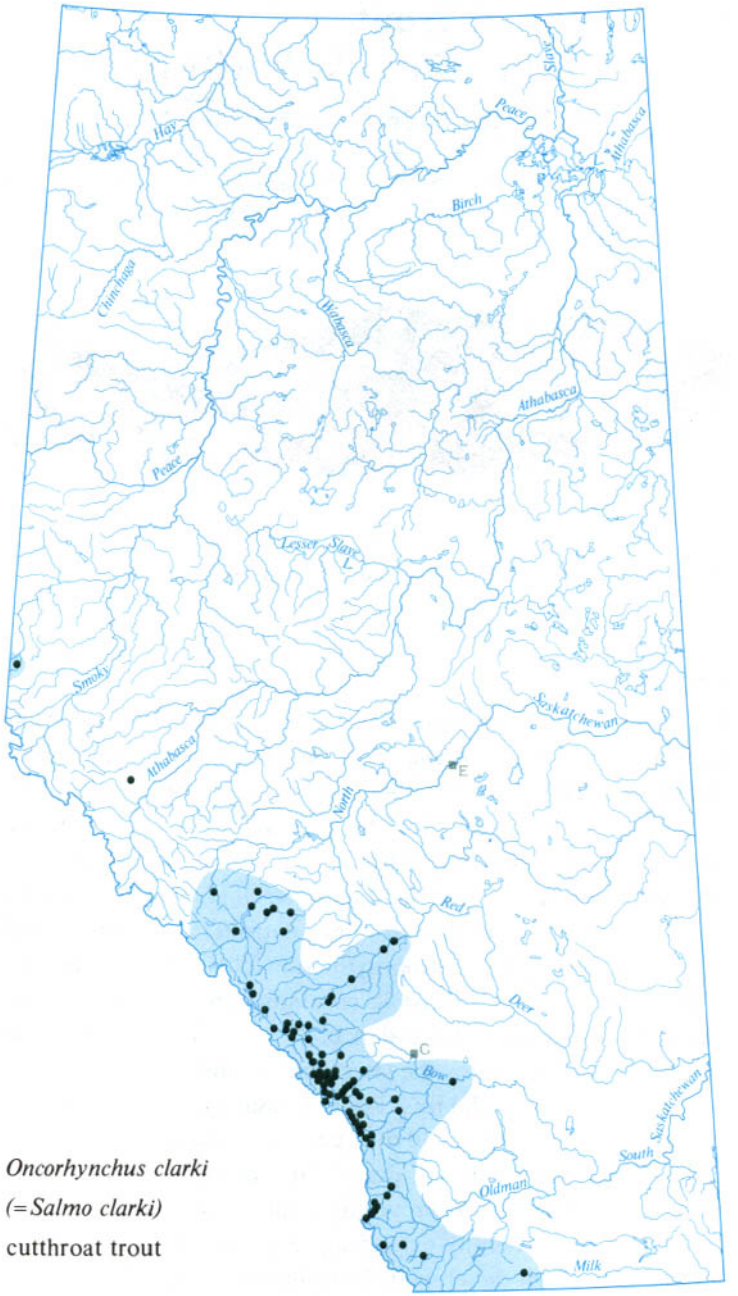
[*Onco rhynchus:* hooked snout; *clarki:* after Capt. W. Clark, of the Lewis and Clark expedition; *Salmo:* the latin name for the Atlantic salmon, meaning "to leap"]

Cutthroat trout from Job Lake. Photo courtesy of W. Schenk.

Description

Color: The following color description applies to only some Alberta populations; there is much variation between localities due to genetic and environmental effects. Also, many fish referred to as cutthroats may be hybrids with rainbow trout. Body yellowish-green with lower sides and belly somewhat reddish, bright red in some individuals at spawning time. A rosy band along each side of the body from cheek to tail, characteristic of rainbow trout, is present in many Alberta cutthroats. Red streaks in the skin folds along the inner edge of the lower jaw give this fish its common name. These red streaks fade rapidly after death. Large dark body spots most numerous above the lateral line and below the lateral line posteriorly. Spots on dorsal, adipose, and caudal fins. Roof of mouth whitish in spawning males. Young with about 10 oval parr marks along the lateral line and a dark leading edge of dorsal fin. Young cutthroat trout are difficult to distinguish from young rainbow trout.

Body: Upper jaw generally extending to posterior margin of eye in adults. Teeth well developed, including on shaft of vomer; very narrow space between vomerine and palatine teeth anteriorly. Basibranchial ("hyoid") teeth present, rarely absent but sometimes very small and very careful examination under magnification is



Map 16.8 Distribution of cutthroat trout in Alberta.

required to see them Caudal fin moderately forked. Scales along lateral line 116-230 (in Alberta usually 150-200); above lateral line 32-50; around caudal peduncle about 50. Principal dorsal fin rays 8-11 (all rays 10-13) and principal anal fin rays 8-12 (all rays 11-14). Gillrakers 15-23. Pyloric caeca 24-60. Vertebrae usually 60-64.

Size: Maximum size for the species is about 99 cm long and weight about 18.6 kg (from Pyramid Lake, Nevada).

Alberta

Maximum weights in Alberta are 4.3 kg from the South Castle River and 4.1 kg from Lower Kananaskis Lake. Usual maximum length in most localities in Alberta is 32 cm, but in some areas, such as the Ram River drainage, they may live long enough to exceed 50 cm.

Distribution

● Two widely distributed forms of cutthroat trout are recognized as indigenous (native) in Canada. The Pacific form, the coastal cutthroat trout, occurs from southeastern Alaska to northern California in the Pacific drainage. Anadromous (sea-run) populations occur along much of the coast; other populations in the same area may be completely freshwater. The interior form, termed the "westslope cutthroat trout," *O. clarki lewisi*, occurs in southeastern British Columbia, southwestern Alberta, and Montana (the name "westslope" is used for this subspecies even though it also occurs on the eastern slopes of the Rocky Mountains).

■ Native in Alberta to the Bow and South Saskatchewan river drainages and introduced into the Peace (Torrens River), Athabasca (Mowitch Creek in Jasper National Park where it has spread downstream and may, unfortunately, be hybridizing with the native Athabasca rainbow trout, *O. mykiss*), North Saskatchewan, and Red Deer River drainages (see Map 16.8). One specimen has been collected from the Milk River (Willock 1969b). Due to fish stocking activities, which included introducing competing trout and hybrid cutthroat trout, and natural hybridization with rainbow trout, there are few native populations left in Alberta. Picklejar Lakes and a few lakes in Banff National Park contain native stocks. The Ram River drainage has an introduced pure stock which was obtained from southeastern British Columbia. James M. Rennels of Calgary is doing a study of the introduction of this species into Marvel Lake, Banff National Park, from the former Spray Lakes hatchery near Canmore; Marvel Lake was the

source of fish for Job Lake which has served as the main source for stocking cutthroat trout in Alberta since about 1970. In the strictest sense we suspect that there are very few pure stocks left—i.e., stocks that are native to a locality and have never been contaminated by other stocks from hatchery operations so that the fishes' biochemical features would reflect selective forces of the locality. See "Historical Note" for further information.

Biology

Cutthroat trout occur in lakes and streams up to 2330 m elevation. The highest population in Alberta occurs in Redoubt Lake, east of Lake Louise, but this population may not be native. Their chief food consists of insects, crustaceans, and fish; large individuals may take small mammals.

During a study of Alberta mountain lakes, Anderson (1980) found an interesting relationship between the invertebrate community in a lake and its fish predators. The invertebrate community in a lake with cutthroat trout (and to a lesser extent those with bull trout) was more similar to the community in a pristine alpine lake with no fish than it was to the community in lakes with other salmonids such as brook trout and rainbow trout.

Cutthroat trout spawn in late spring and early summer when the water temperature reaches 10°C. Spawning usually occurs in gravelly streams but spawning on beaches or shallow shoals apparently occurs in some lakes (Carl and Stelfox 1989). The female prepares a nest, or redd, by thrashing her tail to displace gravel until a depression about 30 cm wide and 12 cm deep is dug. A male fertilizes the eggs deposited by the female, and the eggs are covered with about 15 cm of gravel by the female dislodging gravel at the upstream margin of the redd. The average egg number produced in one year by cutthroat trout confined to freshwater is about 1,100. The eggs hatch by August or earlier, depending on the temperature, and the young remain in the gravel for about a week and then disperse. Cutthroat trout mature by age 2 to 4, when the fish is about 20 cm long. They have a relatively short life span, but individuals of about age 8 have been caught in the Ram River. Cutthroat trout are relatively easy to catch by angling and heavy fishing pressure may remove many of the larger fish, leaving populations composed primarily of young fish.

Experiments at Gorge Creek, part of the Sheep River system southwest of Calgary, showed that cutthroat trout occupy discrete home

territories and if individuals are moved, they can generally return "home" (Miller 1954, 1957). This is probably also true of all trout. Other studies at Gorge Creek showed that when hatchery-reared cutthroats and other trout are released into an area, the resident wild trout force the "immigrants" out of resting areas which can lead to very high mortality (Mangan 1951; Thomas 1953; Miller 1955, 1958b). However, in some Alberta areas, the introduction of rainbow and brown trout has been followed by decreased numbers of the native cutthroat trout. Cutthroat and rainbow trout often hybridize in Alberta (Andrekson 1949; Gilmour 1950; Miller 1950b). Hybrids were occasionally deliberately produced for stocking in areas such as in the Kananaskis River system (Nelson 1965).

For a detailed review of cutthroat trout see Trotter (1987) and Gresswell (1988).

Angling

Cutthroat trout may be taken on wet or dry flies or with small spinning lures or with bait. Late July and August are favored for dry fly fishing on streams. At this time, well hackled dry flies such as Adams and gray or brown bivisibles are popular patterns. Stream fishing for cutthroat is now restricted to upper reaches of mountain streams such as the tributaries to the Castle, Oldman, Highwood, and Ram river systems. Good cutthroat fishing is also available in some lakes of Banff National Park. The range of this species is being extended through introductions to, for example, the Bighorn River and the Torrens River. Numerous small mountain lakes are currently being stocked with cutthroat trout and are providing wilderness type fishing experiences. The flesh of cutthroat trout is excellent and the fish is of great recreational value to the sportsman.

Historical Note

Sir John Richardson first described the cutthroat trout in 1836 from Cathlapootl River, Washington, as *Salmo clarkii*. It was first reported in Alberta by Eigenmann (1895) from Calgary and Banff as *Salmo mykiss*. Vick (1913) noted it to be widespread in the Banff National Park area (e.g., Boom, Harrison, Consolation, Moraine, Mystic, Sawback, Hector, Bow, Margaret, and Spray lakes and Redearth Creek) and at Twin Falls between Upper and Lower Kananaskis lakes (this waterfall is now dry and the lake levels have now been raised and the waters managed for hydroelectric power production), Lower Kananaskis Lake, and the

Kananaskis River. Cutthroat trout are now almost absent from the Kananaskis system (Nelson 1965). Vick (1913) also noted that Lower Kananaskis Lake "contains the finest Cut Throat Trout in the mountains" and that the lake was the fish supply depot for the Morley band of Stoney Indians.

The taxonomy of the cutthroat trout has been studied in detail by Behnke (1979). Several subspecies are recognized, but their status and relationships are uncertain. The subspecies *Oncorhynchus clarki lewisi*, the westslope cutthroat trout, is the one indigenous to Alberta. However, another subspecies, *O. clarki bouvieri*, the Yellowstone cutthroat trout, has been propagated in hatchery operations. D.J. McAllister, F.W. Allendorf, and S.R. Phelps, in a 1981 study of cutthroat trout in the Bow, Kootenay-Columbia, and Waterton River systems for Parks Canada, identified pure Yellowstone cutthroat trout in Taylor Lake (Bow River drainage) and a hybrid swarm of Yellowstone and westslope cutthroat trout in Baker Lake (Bow River drainage) and in Sofa Creek (Waterton River drainage). Westslope cutthroat trout were verified from several other localities. Additional studies include one on pure populations of the westslope form in Picklejar and Job lakes (Carl and Stelfox 1989); the Picklejar Lakes populations are unusual and should be protected. Ferguson (1990) discusses hybrid swarms of Yellowstone and westslope cutthroat trout in Montana and gives reasons for not mixing native and introduced taxa.

For reasons why most biologists now place this species in the genus *Oncorhynchus* see "Historical Note" in Section 16.9 Rainbow Trout (*Oncorhynchus mykiss*).

16.9 Rainbow Trout *Oncorhynchus mykiss* (Walbaum) (=*Salmo gairdneri* Richardson)

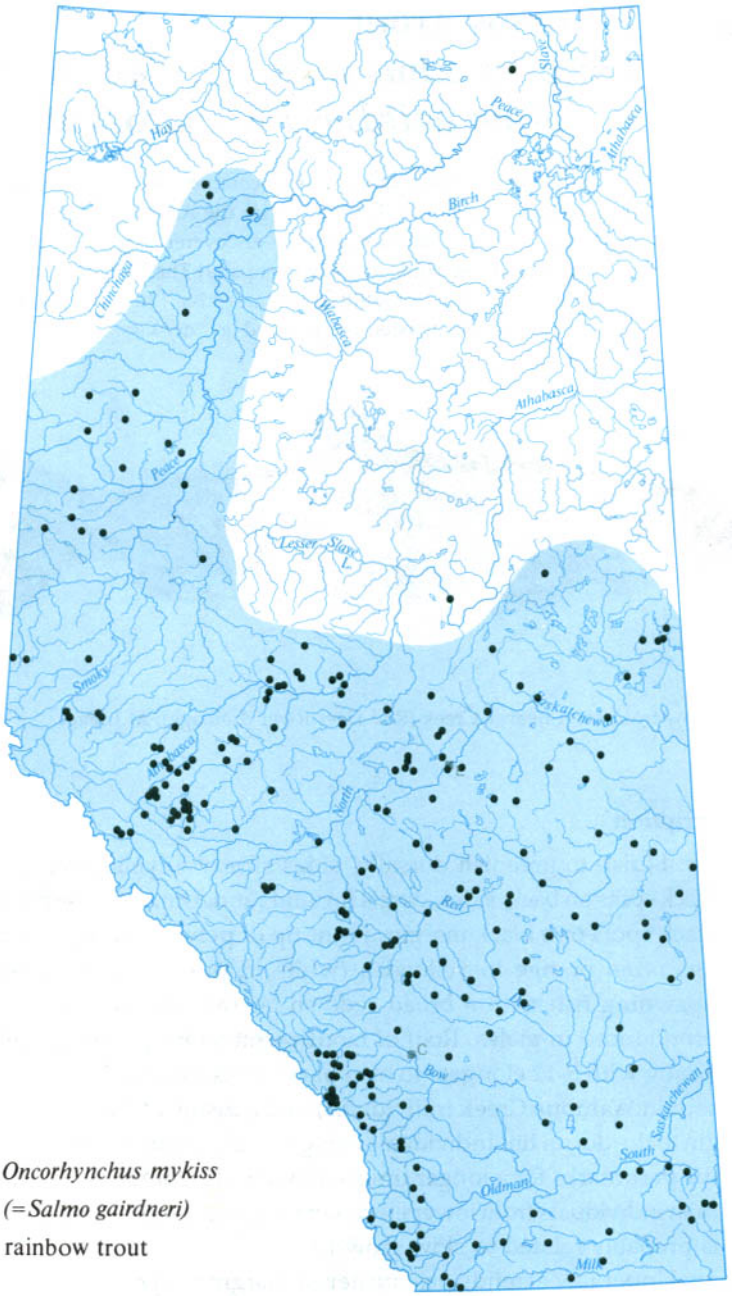
[*Onco rhynchus:* hooked snout; *mykiss:* common name of the species in Kamchatka; *Salmo:* the Latin name for the Atlantic salmon, meaning "to leap"; *gairdneri:* after its discoverer, Dr. M. Gairdner, an employee of the Hudson's Bay Company] The specific name "*mykiss*" is correctly pronounced as "mee-kiss"; however, in North America it has usually been pronounced as "my-kiss".

Rainbow trout from Beaver Creek (Red Deer River drainage). M.J. Paetz.

Description

Color: Bluish to greenish dorsally, sides silvery to yellowish-green. Black spots on back, sides, dorsal fin, and caudal fin. Adipose fin with black spots or a black margin. Front tip of pelvic, dorsal, and anal fins often orange to yellowish (white in preserved specimens). Spawning fish with a broad reddish lateral band which is most pronounced in males. Roof of mouth whitish in spawning males. Young with 8-12 elongate to oval parr marks along side (rarely absent in Wampus Creek individuals) and a distinct black front margin to the dorsal fin. Individuals living at high altitudes tend to retain the parr marks for a longer time and have a brighter colored fin tip than individuals from lower elevations (the persistence of parr marks is probably related to slow growth).

Body: Upper jaw extends past posterior margin of eye in fish over 10 cm. Teeth well-developed, including those on shaft of vomer; little or no space between vomerine and palatine teeth anteriorly. Caudal fin moderately forked. Scales along lateral line 100-148; above



Map 16.9 Distribution of rainbow trout in Alberta.

lateral line 18-32; around caudal peduncle about 40. Principal dorsal fin rays 9-12 and anal fin rays 8-12. Gillrakers 16-21. Pyloric caeca 26-80. Vertebrae 60-66.

Size: Maximum length 122 cm (a steelhead) and weight 23.6 kg (a rainbow from Jewel Lake, B.C.)

Alberta

Vertebral number in 49 specimens from Deerlick and Wampus creeks, Athabasca River drainage: 63 in 12 specimens, 64 in 19, 65 in 16, and 66 in 2. In addition, they had 9-11 principal rays and 3-5 rudimentary elements in the dorsal fin.

Maximum weight in Alberta is 9.7 kg from the first of the Five Finger Lakes in Jasper National Park (the fish is pictured in Butler and Maw 1985), and greatest known maximum length is 87.5 cm from Payne (= Mami) Lake.

Distribution

● Rainbow trout are native in Pacific coastal areas in northeastern Asia and from southeastern Alaska to northern Mexico and inland to the Peace River and Liard River drainage in British Columbia and the Athabasca River drainage of Alberta. Its natural distribution extends farther south in North America than that of any other member of the trout family. Along coastal areas there are populations of "anadromous" or "sea-run" *Oncorhynchus mykiss*; these fish spawn in fresh water, then migrate to the ocean for several years. The common name for these trout is "steelhead." Rainbow trout have been successfully introduced across North America and onto all continents except Antarctica.

■ As noted in Paetz and Nelson (1970), several populations in the Athabasca River drainage from the south slope of the Swan Hills to the headwaters of the Athabasca River in Alberta are believed to be native. Employees of the Grand Trunk Pacific railway reported rainbow trout being abundant in areas near Hinton and Jasper in 1910 and 1911. In addition, and of greater interest, Dr. Walter Cheadle describes catching some 2 oz trout in the Athabasca River drainage, probably near Edson, that were like the English burn (= brown) trout, with black spots and a narrow red line along each side (Cheadle, 1931, p.150). This was 14 June, 1863, and almost certainly refers to the small native Athabasca rainbow trout (as noted by Van Tighem 1988). Unfortunately, there undoubtedly has been mixing of introduced and native rainbow trout

and hybridization with cutthroat trout in many Athabasca streams; we believe that many parts of the Freeman River and the Wampus Creek area along with other tributaries of the McLeod River system retain the original form. Rainbow trout that are not native to Alberta have been successfully introduced into western Alberta in the Athabasca, North Saskatchewan, Red Deer, Bow, and Oldman river drainages and in the Cypress Hills area; introductions have also been made in Milk River drainage (see Map 16.9; shaded area indicates where there is active or potential stocking). Generally, however, many of Alberta's streams, pothole lakes, and reservoirs seem unsuitable for rainbow trout reproduction. Rainbow trout are commonly stocked in small ponds on private land where they grow rapidly but usually can not overwinter and are harvested in late summer and early fall.

Rainbow trout were introduced into the northeastern part of Alberta, in Pine Lake south of Fort Smith in Wood Buffalo National Park, starting in 1958. In 1959, Pine Lake was restocked and fry were also introduced into the five Rainbow Lakes, Seven Mile Lake, Little Buffalo River above Campbell Falls, and Salt River (unpublished report of N.S. Novakowski). No reproduction is known from the above localities.

Biology

Rainbow trout, like other members of the salmon family, thrive in cool waters. They are able to tolerate temperatures up to about 24°C if there is sufficient oxygen but they do best in temperatures below 20°C. They occur both in streams and lakes. The term "steelhead" is often applied to large trout caught in the Bow River in the Calgary area; however, since no sea-run populations occur in the province the term is inappropriate. Rainbow trout feed primarily on insects (aquatic and terrestrial), leeches, molluscs, crustaceans (e.g., amphipods), and occasionally on small fish. When present, a small "shrimp," *Mysis relicta*, is a favorite item in their diet. This crustacean is native to Waterton Lakes and has been introduced into a number of other lakes (e.g., Upper and Lower Kananaskis Lakes and Spray Lakes Reservoir by way of Kootenay Lake).

The biology of the native Athabasca trout differs in some details from that of introduced rainbow trout in southern Alberta. The general biology of a few rainbow trout populations in the Athabasca River drainage is provided by Dietz (1971) and Sterling (1990). The former study was designed to provide baseline data to determine the effects of pulpwood logging in an area northeast of Cadomin known as the

Tri-Creeks watershed (comprising Wampus, Deerlick, and Eunice creeks, part of the McLeod River drainage). Sterling (1990) provides a postlogging evaluation.

Native trout in the Tri-Creeks area spawn later than do more southerly occurring introduced trout. Sterling (1990; personal communication, 1991) reports that spawning commences at about 6°C with the water temperature during egg incubation to hatching to range from a mean of 6.3°C (the range in means over four seasons was 5.3-7.5°C, in upper Deerlick Creek) to a mean of 9.8°C (the range of means over eight seasons was 8.5-12.0°C, in lower Wampus Creek). In upper Deerlick Creek, where known spawning times are the latest in Alberta, spawning generally commences in late June and hatching occurs as late as September. In known introduced populations, however, spawning occurs in late spring and early summer. Low altitude individuals spawn earlier than high altitude ones; those in the lower reaches of the Highwood and Sheep rivers (altitude about 1000 m; making up most of the naturally reproducing rainbows in the lower Bow River) spawn from late April through May while most of those in Amethyst Lake (altitude 1966 m) spawn into mid-July. The water temperature at spawning is usually between 10° and 15°C. Most spawning occurs in small tributaries to rivers or in inlet or outlet streams of lakes, usually in fine gravel or in a riffle. As with cutthroat trout, the females dig a nest or "redd" in the gravel (see "Biology" under Section 16.8, Cutthroat Trout, for general comments on spawning behavior). Maturity is usually reached by age 3 or 4. The maximum life expectancy is normally 5-9 years but they may live to age 13 or more (Donald and Alger 1986a). Rainbow and cutthroat trout frequently hybridize in Alberta (Miller 1950b; Gilmour 1950).

The habitat of rainbow trout has a strong effect on their growth rate. There is a remarkable difference in the growth rate of individuals in various populations in Alberta that is related to differences in the bodies of water. There are localities where there is about the fastest growth rate (those stocked in Tyrrell Lake, southeast of Lethbridge) and the slowest growth rate (the native rainbows in the Tri-Creeks area, in McLeod River drainage) observed in North America. Indeed, from the data of Dietz (1971; Table 7 and Fig. 22) and Sterling (1990; personal communication, 1991) it appears that individuals in Eunice, Deerlick, and Wampus creeks, respectively, may be the slowest growing rainbow trout known in the world. At age 2 in Upper Eunice Creek they are under 10 g in weight and are about 52 mm in length. Wampus Creek

fish at age 2 are between 10-20 g in weight. This is slower than the previously reported record low of 40 g for age 2 fish in a small lake in Utah (Donaldson and Anderson 1982). However, while the Tri-Creek native trout could differ genetically from introduced trout in some aspects of their growth rate, the experimental study of Sterling (1989) demonstrated that there is good growth potential in more favorable habitats and consideration should be given to their hatchery production (regardless of their growth rate they should be valued, as a native stock, for what they are). The enormous plasticity of growth in fishes is clearly shown by the study of Donald and Anderson (1982) on rainbow trout. They found in age 2 fish from 16 stocked mountain lakes in western Alberta that the weight varied from 2,066 g (Mina Lake, Jasper National Park) to 117 g (Kingfisher Lake, Banff National Park). In general, trout stocked in high altitutde lakes such as Amethyst and Pyramid show relatively slow growth rates while those stocked in warm pothole lakes grow rapidly.

Fishing is generally good for the first few years in many pothole lakes and reservoirs that are stocked with rainbows. Success usually decreases as the large trout, which are less frequently caught by fishermen, become proportionately abundant. Modern lake rehabilitation programs are often necessary to maintain a high degree of fishing success. The trout may live through very low oxygen conditions in the winter, although exceptionally low oxygen concentration results in winterkill and these lakes must be restocked to maintain angler success.

A species of tapeworm, *Diphyllobothrium* (not *D.* (=*Dibothriocephalus*) *latum*), was found in a high proportion of the rainbow trout taken by M. Denny in the Kananaskis Lakes in 1962. These may be one or more of the seven species found in rainbow trout of the Kootenay Lake area, British Columbia, by Anthony (1967).

Angling

This highly rated sport fish may be taken by a wide variety of fishing methods. Rainbows are taken on practically all kinds of lures and baits from willow leaf trolls to salmon eggs. Fly casting and spinning are generally the most popular techniques with local exceptions. In waters where forage fish are the dominant foods items, trolling and spinning generally yield good results. Fly fishing is favored in ponds, lakes, and streams in which insects are the staple food. Many local fly patterns have been designed especially for taking rainbows in the numerous stocked lakes throughout the province. The immense popularity of this

trout among anglers is due largely to its spectacular aerial acrobatics when hooked. In addition to the abundant lake fisheries for rainbows, the Bow River between Calgary and Gleichen, the Crowsnest River, and the Oldman River have achieved international acclaim as rainbow trout fisheries.

Historical Note

Sir John Richardson first described the rainbow trout in 1836 from the Columbia River at Fort Vancouver as *Salmo gairdnerii*. Bajkov (1927), referring to it as *S. irideus*, described the morphology of specimens collected in Jasper National Park. He named a morpha, *S. irideus argentatus*, from Buffalo Prairie Lake, Caledonia Lake, and the Athabasca River; the typical rainbow trout was noted to be also present in these waters.

It is ironic, but there is some uncertainty about what name to use for this species, one of the most popular and most studied sportfish in fresh waters in North America. The native Alberta populations are especially in limbo for appropriate nomenclature.

Behnke (1979) has shown that what is commonly called the "rainbow trout" is actually a complex of diverse forms. While acknowledging that it may be an oversimplification, he recognizes two species in the complex:

i) *Salmo gairdneri* (rainbow trout) for the Pacific coastal form that in British Columbia is usually restricted to coastal areas. Populations in parts of the upper Liard (e.g., Turnagain system), part of the Mackenzie River drainage, now thought to be native, were probably derived from Stikine River stocks by way of high-altitude marshy areas (John Kristensen, personal communication) and would thus also be of this form.

ii) *Salmo newberryi* (redband trout) for the inland form that in Canada is recognized as native to the Fraser-Thompson drainage, essentially above Hell's Gate. This therefore includes the trout in the Kamloops area, in the Columbia River drainage, in the upper Peace River drainage, and, for Alberta, those in the upper Athabasca River drainage. We believe that the native Athabasca trout were probably derived from the Fraser River drainage via Moose Lake—this of course, could have occurred well over 10,000 years ago with occupancy in an early ice-free area. "Rainbow" trout in Alberta outside the Athabasca River drainage have been introduced from elsewhere (e.g. Kootenay Lake) via hatcheries. Such hatchery introductions can cause considerable problems in taxonomic studies. The

status of redband trout is uncertain. Based on the study of Wishard et al. (1984), all such trout populations included in it are not necessarily each other's closest relatives. In addition, the native Alberta trout, such as those occurring in Wampus Creek, seem to be relatively different from other trout (L.M. Carl, personal communication).

In contrast to the view that more than one species of "rainbow trout" may be present, some research using techniques in molecular biology suggests that all rainbow trout forms are of the same species that may also include golden trout and perhaps even cutthroat trout.

There are also problems at higher taxonomic levels. As noted in Bailey and Robins (1988), there is little doubt that what has classically been regarded as the rainbow trout in North America is of the same species as the Kamchatkan trout (*Salmo mykiss* Walbaum) of northeastern Asia and should be referred to under the latter name by priority. Although it is not a new idea that a North American trout is conspecific with an Asiatic one, it has not always been certain whether it was our cutthroat trout or rainbow trout series that was most closely aligned with *Salmo mykiss* of Asia; e.g., in Jordan and Evermann's 1896 "Fishes of North and Middle America," the cutthroat trout series is recognized under *S. mykiss*.

Bailey and Robins (1988) also note a problem at the generic level for the western trouts (e.g., cutthroat, golden, and rainbow). According to our present understanding of relationships and methods of classification they should not be recognized in *Salmo* (consisting of brown trout and Atlantic salmon). There is merit to lumping the lineage of rainbow trout and cutthroat trout with *Oncorhynchus* (Pacific salmon) as advocated by Smith and Stearley (1989) and accepted by the AFS-ASIH Committee on Names of Fishes (Robins et al. 1991). This makes our "rainbow" trout *Oncorhynchus mykiss, O. newberryi,* and/or perhaps some other taxon. However, there is also some merit to recognizing the Pacific trout in their own genus (i.e., *Rhabdofario* = *Parasalmo*). The one thing that seems certain is that they should not be placed under *Salmo*. Because of unresolved questions both at the generic and the specific level we reluctantly follow the changes in Robins et al. (1991) and recognize the Pacific trout and the Pacific salmon in the genus *Oncorhynchus* (it is not suggested that common names be changed to reflect the change in the generic name for Pacific trout). Ongoing studies using techniques in molecular biology may well show relationships to be different than those presently understood. We think for a group so widely referred

to in the literature that it is best not to change names pending more taxonomic work in order to avoid a further change in names. It is important to note that our native populations in the Athabasca River drainage, such as in the Wampus Creek area, may be taxonomically unique and should be managed accordingly. They deserve special protection, separate from that of stocks introduced from outside Alberta.

16.10 Golden Trout *Oncorhynchus aguabonita* (Jordan) (=*Salmo aguabonita* Jordan)

[*Onco rhynchus:* hooked snout; *agua bonita:* beautiful water, a Spanish name; *Salmo:* the Latin name for the Atlantic salmon, meaning "to leap"]

Golden trout. Photo courtesy of C. Parke.

Description

The golden trout is somewhat similar to the rainbow trout but it is usually much more colorful. It tends to have more and smaller scales, a paler yellowish-green body, fewer but larger body spots, brighter orange or white tips to the fins, and more pronounced parr marks in the adult.

Distribution

● The native distribution of this trout is probably only at elevations over 3000 m within the Kern River drainage in the Sierra Nevada Mountains of California. It has been introduced into many high altitude lakes and streams in western North America.

■ In Alberta, introductions were made from a Wyoming source into several high-altitude lakes in the southern Rocky Mountains (several lakes of the Castle River system in the Oldman River drainage; Three Isle and Galatea lakes of the Kananaskis River system; and Gap Lake, southeast of Nordegg of the North Saskatchewan River drainage). It is no longer present in the Kananaskis River system or in Gap Lake, but it is present in the Castle River system in Barnaby Lake, Upper South Fork Lake, and Lower South Fork Lake (these three are collectively known as the Barnaby Ridge lakes), and in Rainy Ridge Lake. Reproduction seems to be successful only in Lower South Fork and Rainy Ridge

lakes. Some lakes in the Nordegg area, for example Coral Lake in the Cline River drainage, have also been successfully stocked.

Biology

Much of the general biology of the golden trout is similar to that of the rainbow. It spawns somewhat later than the rainbow and is generally better adapted than other salmonids to high elevations. In South Fork Lakes in Alberta, spawning occurs in early July. Since the golden trout is only in a few remote mountainous lakes it is not the target of the majority of fishermen. The largest golden trout reported in Alberta is a 2 kg individual taken from the South Fork Lakes. Golden trout are more closely related to rainbow trout than to cutthroat trout and some recent workers consider the two species to be conspecific.

Angling

Golden trout were introduced into a few selected lakes with a view to providing additional variety to the province's sport fishing. The most popular lakes are the South Fork Lakes and Rainy Ridge Lake in extreme southwestern Alberta. Recommended angling techniques are similar to those used for cutthroat and rainbow trout. Small lures and flies cast from the lake shore are generally the most successful methods of taking this colorful fish.

Historical Note

D.S. Jordan first described the golden trout in 1892 from California as *Salmo mykiss agua-bonita*. Golden trout were first introduced into Alberta in 1959 into South Fork Lakes.

16.11 Brown Trout *Salmo trutta* Linnaeus

[*Salmo:* the Latin name for the Atlantic salmon, meaning "to leap"; *trutta:* trout]

Brown trout from Alford Creek. M.J. Paetz.

Description

Color: Golden-brown or olive dorsally and laterally. Body with large black or dark brown spots, many with a pale halo; some pink or red spots on the sides. This is the only salmonid with light and black spots on body. No vermiculations. Red spots (white in preserved specimens) along the lateral line and alternating with the parr marks in young longer than about 7 cm. Few or no spots on the caudal fin. Young with 9-14 broad parr marks (elongate in very young) along the sides. Young about 2.5 cm long have a black leading edge to the dorsal fin and no spots, those over about 6 cm develop black spots and a whitish tip lined with black on the dorsal fin. Adipose fin orange with lightish margin in young, never lined with black. The young are difficult to distinguish from young Atlantic salmon, which have been introduced into western Alberta (see Appendix I).

Body: Upper jaw usually extending past posterior margin of eye in fish over 5 cm long. Teeth well developed, including on shaft of vomer; little or no space between vomerine and palatine teeth anteriorly. Caudal peduncle relatively deep. Caudal fin only slightly forked to squarish. Scales along lateral line 110-130; above lateral line about 25-28; around caudal peduncle about 44-46. Principal dorsal fin rays 12-14 and anal fin rays 9-12. Gillrakers 16-19. Pyloric caeca 35-65.

Map 16.11 Distribution of brown trout in Alberta.

Vertebrae 56-61. Generally, males have a rounded anal fin margin whereas females have a slightly falcate anal fin margin.

Size: Maximum length is 105 cm (girth 72 cm) in a 17 kg hatchery produced brown trout caught in Lake Storsjön, Sweden, 16 October 1991, as reported by Kent Andersson of Göteborg, Sweden. The North American maximum length is about 99 cm and maximum weight 17.9 kg in a brown trout caught in Arkansas in 1988 (a weight of about 0.5-2 kg is average for an adult).

Alberta

Vertebral number in 67 specimens: 57 in 8 specimens, 58 in 8, 59 in 36, and 60 in 15.

Maximum length in Alberta is 87 cm total length (49 cm girth) and maximum weight is 7.96 kg in a fish caught by Wesley Benson, 15 December 1991 from Swan Lake, southwest of Rocky Mountain House and west of Caroline. The previous weight record is 7.2 kg, in a fish also from Swan Lake. Other large sizes include 78 cm fork length from Lake Edith, Jasper National Park, and 60 cm fork length from the North Raven River system.

Distribution

● Native from Iceland to the White Sea area and from Morocco through Algeria to Turkey; Caspian and Aral seas. Anadromous (sea-run) populations occur in coastal areas. This species has been successfully introduced into more areas than any other salmonid. Populations occur on all continents, except Antarctica, including areas on and near the Equator. Various stocks have also been exchanged within Europe.

■ Brown trout have been successfully introduced throughout much of western Alberta in the Athabasca, North Saskatchewan, Red Deer, Bow, Oldman, and, with limited success, North Fork Milk river drainages (see Map 16.11).

Biology

Brown trout occur in streams, beaver ponds, and lakes. Their food consists of terrestrial and aquatic insects, fish, and occasionally other invertebrates and vertebrates. In Barrier Lake, a reservoir where, except for the chironomids, the benthic invertebrates usually found in natural lakes are virtually absent, Seghers (1988) found the brown trout in October to be feeding primarily on ants, corixids, and beetles. Individuals generally lie in deep pools or under protective covering,

often under banks or snags. The young are highly territorial, tending to hide under rocks and aggressively defending their areas from other fish.

Spawning is in the fall (primarily October to December), as in the chars and unlike in other trout. Hatching probably occurs in late April. Females produce an average of 1,200 eggs of about 4.7 mm in diameter and, like other trout, dig the nest. "Bill Griffiths Creek," a very short tributary to the Bow River downstream from Canmore on the north side of the Bow and historically a side-channel, supports an unusually large number of spawning brown trout and accounts for a large proportion of spawning brown trout in the upper Bow River system (K. Brewin, personal communication, 1991). Brown trout and brook trout sometimes hybridize in nature, producing "tiger" trout (in Alberta, hybrid specimens are known from North Raven River (Allan 1977), Tay River (M. Kraft, personal communication, 1980), and possibly from the Bow River near Canmore (J.D. Stelfox, personal communication, 1988). Seghers (1988) found individuals of this species to live to at least 10 years of age in Barrier Lake.

Brown trout are more closely related to Atlantic salmon than they are to any other trout. In Alberta, as elsewhere, brown trout appear to be partly responsible for the decline of some native trout and char populations.

Angling

Brown trout are probably the most difficult to catch of all Alberta's sport fish and therefore are one of the species most able to cope with heavy angling pressure. The most popular areas for angling for brown trout are in streams of lower elevations in the area southeast and southwest of Rocky Mountain House and in the Bow River from Banff to Carseland. In these streams the currents are moderate and there is abundant cover in the form of rooted aquatic plants and sunken logs—conditions preferred by brown trout. Fly fishing, both wet and dry, is a popular form of angling but spinning lures and bait are also used. Angling for brown trout is often most successful in late afternoon and into the evening.

Historical Note

C. Linnaeus first described the brown trout in 1758 from rivers of Sweden as *Salmo trutta*. First introduced into North America (Michigan) in 1883 from Germany and into Canada in 1884 (Newfoundland)

from Scotland (the Loch Leven variety) and 1890 (Quebec) from Germany via New York. First introduced into Alberta in 1924 (Raven River and Jasper National Park) and 1925 (Bow River System—this stock, probably the Loch Leven variety, was introduced into Carrot Creek northwest of Canmore just within Banff National Park when the hatchery truck which was destined for eastern Alberta from Banff, broke down). Bajkov (1927) described the species from Jasper Park.

16.12 Bull Trout *Salvelinus confluentus* (Suckley)

[*Salvelinus*: an old name of the char (charr); *confluentus*: flowing together]

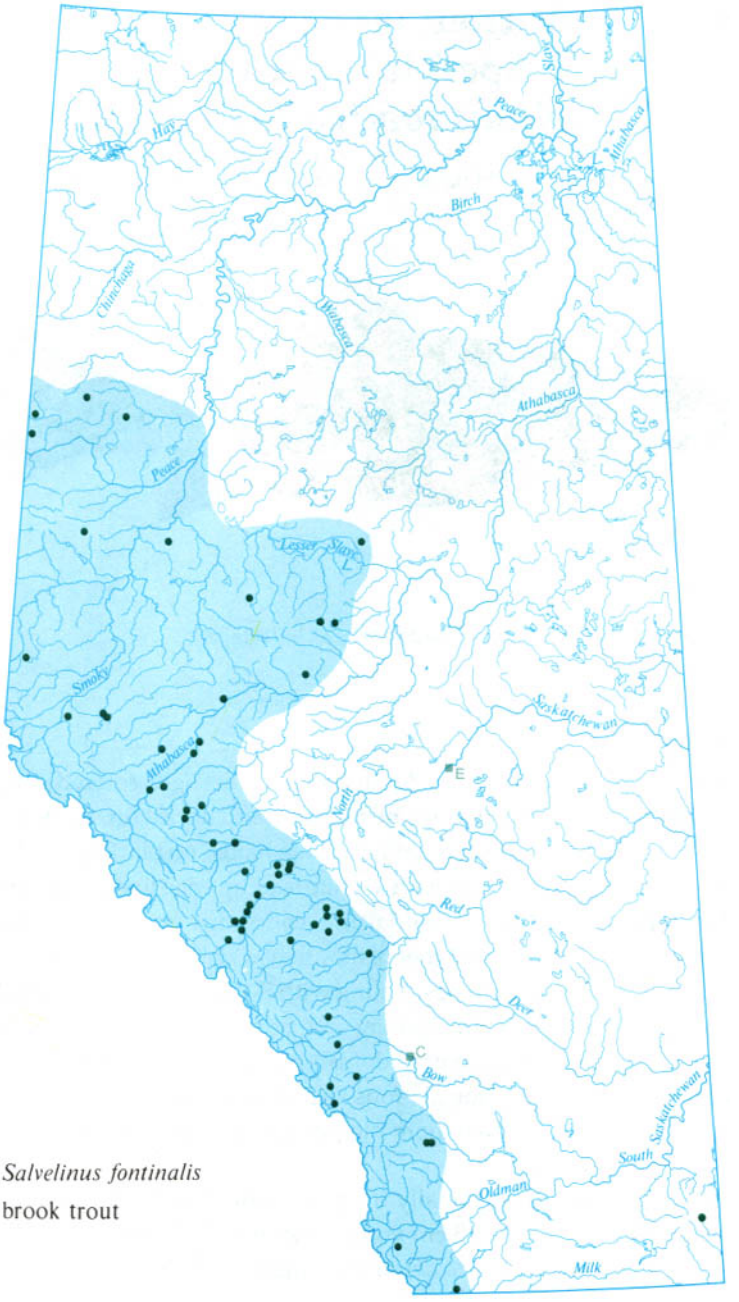
Bull trout from North Saskatchewan River near Whirlpool Point. Photo courtesy of C. Tebby.

Description

Color: Olive-green to blue-gray dorsally with silvery tones laterally. Yellow, orange, or red spots (white in preserved specimens) on dorsal surface and sides. Pelvic and anal fins often with whitish leading edge, not followed with black. Roof of mouth whitish and belly and lower sides sometimes orange to red in spawning males. Young with 7-10 broad squarish parr marks along the lateral line; fins transparent, without black spots.

Body: Upper jaw extending past posterior margin of eye in fish over about 8 cm. Teeth well developed but absent from shaft of vomer; very small gap between vomer and palatine teeth anteriorly. Basibranchial ("hyoid") teeth present or absent. Anterior tip of dorsal fin relatively pointed. Caudal fin moderately forked; only a slight notch in fingerlings. Pored scales along lateral line 105-142; scales one row above lateral line 186-254; above lateral line about 40; around caudal peduncle about 60. Branched dorsal fin rays 9-11 (all rays 13-16) and branched anal fin rays 8-10 (all rays 11-15). Gillrakers 13-22. Pyloric caeca 20-40. Branchiostegal rays (total for both sides) usually 25-30. Vertebrae 62-67.

Size: Maximum length about 103 cm and weight 14.5 kg.



Map 16.12 Distribution of bull trout in Alberta.

Alberta

Vertebral number in 34 specimens from five creeks: 63 in 1 specimen, 64 in 7, 65 in 21, 66 in 4, and 67 in 1.

Maximum known length from Alberta is 86 cm fork length from the Clearwater River. The recognized maximum angling weight is 8.1 kg from a 85 cm specimen from Lower Kananaskis Reservoir (Scammell 1990).

Distribution

● In northwestern North America from southern Alaska to California; on both sides of the Continental Divide in British Columbia and Alberta.
■ Known in Alberta from the Peace (reported from the town of Peace River by Bishop (1973), and Little Rapids in the Peace-Athabasca Delta by Kristensen (1981b)), Athabasca, North Saskatchewan (historically as far downstream as Edmonton, currently perhaps only to Drayton Valley), Red Deer, Bow, and Oldman river drainages (see map 16.12). There has been a significant reduction in the range of this species, even from that shown in the map, especially in the eastern portion of their range in Alberta. For example, it was known to be common in the Edmonton area of the North Saskatchewan River up to the 1930s and the last known individual was obtained in 1957. A downstream population in the Oldman River, perhaps the last population to occur on the prairies, is also certain to disappear if its migration path continues to be blocked by the recently constructed Three Rivers Dam, as predicted by Roberts (1991).

Biology

Bull trout frequent lakes and streams from sea level to high mountains. Their primary food source is bottom fauna, primarily insects, and other fish (Boag 1987); small mammals and surface food are also sometimes taken. Spawning occurs in the fall (usually September or October) in streams and rivers with a bottom of medium to large gravel. The female digs a redd and deposits, on average, about 5,000 eggs. She then covers them with gravel displaced from immediately upstream of the redd. The eggs hatch about in April. Maturity is usually reached in their fifth year or later. The growth rate of bull trout has been studied in the McLeod River (Dietz 1971) and in Pinto Lake, a lake with no other fish in the Cline River drainage west of Abraham Lake (Carl et al. 1989). In both localities 4 year old fish averaged about 20 cm in length, which shows relatively slow growth compared to that of other known

populations. The bull trout in Pinto Lake were also late maturing and unusually brilliantly colored during spawning.

Hybrids between bull trout and brook trout have been identified from Abraham Lake (UAMZ 3246) (C.D. Tebby, personal communication), Haven Creek (UAMZ 5207), and parts of the Clearwater drainage from Tay River and the Clearwater River near Corkscrew Mountain (e.g., UAMZ 6817) (W.E. Roberts, personal communication). Natural hybrids of this cross also occur in Montana where Leary et al. (1985) found a greater degree of asymmetry between the left and right sides of the fish than in the parental species.

Angling

Although bull trout are occasionally taken by fly fishermen, the most common angling technique is spinning or casting with medium sized lures or bait. They usually frequent the deeper pools of streams or the junctions of tributary streams and larger rivers. In lakes they are caught at various depths by casting or trolling. In recent years, concerns over depletion of bull trout populations has led to additional protection for this species through more restrictive angling regulations.

Historical Note

The taxonomic history of the bull trout is particularly complicated (Cavender 1978). This species was first described by C.F. Girard in 1856 as *Salmo spectabilis*, the holotype having been collected by G. Suckley. This name, however, cannot be used under the rules of zoological nomenclature. Of the available names, including *S. campbelli*, *S. bairdii*, and *S. parkei*, Cavender (1978) recognized G. Suckley's 1858 description of *S. confluentus* from the Puyallop River in Washington State to represent the bull trout (the species being later recognized in the genus *Salvelinus*). In the early years, some biologists on the basis of Suckley's description thought that this species was the same as the chinook salmon; apparently his description was based on a bull trout head but the skin of a Pacific salmon!

The bull trout and the anadromous Dolly Varden, *Salvelinus malma*, were for a long time (from about 1882-1978) considered to be the same species. Cavender (1978) and Haas and McPhail (1991), however, provide evidence that they are distinct. Formerly, when we recognized Dolly Varden and bull trout together under the name of Dolly Varden, most inland fishermen referred to this species as the bull trout. It was thus with some chagrin, after correcting many fishermen about the

name, to find ourselves now adopting the name bull trout. Actually, Cavender (1978) believes that the term "Dolly Varden" may have originally been applied in California to our species, but he advises it now be used for the anadromous form because of recent popular usage. With respect to common names, we prefer as more appropriate the name "mountain char" (it has two appropriate descriptive words—it is a char (*Salvelinus*), not a trout (*Salmo* or *Oncorhynchus*); it goes nicely in wording with Arctic char and the often sympatric mountain whitefish). However, the name "bull trout," inspired by the large size of the head and jaws, is the one in common usage. Other common names are "western brook char," "inland char," or "bull char." As an aside, the spelling of the term "char" is also the subject of some controversy. It was long argued by William M. Morton that the preferred spelling is "charr," a spelling adopted by some workers, but we favor the spelling given by Robins, et al. (1980, 1991).

The 5 May 1883 edition of the Edmonton Bulletin contains an account of what was undoubtedly a bull trout (reported as "a 16 1/2 pound salmon trout") caught by Mr. Issac Dagnon in Edmonton at the mouth of Mill Creek (C.D. Tebby, personal communication). Bull trout were first officially reported from Alberta by Eigenmann (1895) from the Bow River at Banff and Calgary and in the Elbow River. Eigenmann listed these specimens as *Salvelinus namaycush* but noted differences between these river forms and the larger ones from Devil's Lake (which are probably properly referred to as *S. namaycush*; Devil's Lake was an early name for Lake Minnewanka). Vick (1913) noted bull trout from "nearly all the mountain lakes and streams" in Banff National Park area (e.g., Boom, Hector, Bow, Mystic, Harrison, Moraine, Sawback, Spray, and Lower Kananaskis lakes) as *Salvilinus parkei*. Whitehouse (1919) recorded them from the Red Deer as *Salvelinus parkii*. This taxon was proposed by G. Suckley in 1861 as *Salmo parkei* from Kootenay River specimens. Bajkov (1927) noted them from Jaques Lake and Rocky River in Jasper National Park as *Salvelinus alpinus malma*.

It is an unfortunate note that extirpation of some downstream stocks of bull trout has occurred and other stocks are seriously depleted; other localities are in danger of losing self-sustaining populations unless increased protection is given to this species.

16.13 Northern Dolly Varden *Salvelinus malma malma* (Walbaum)

[*Salvelinus*: an old name of the char (charr); *malma*: common name in Kamchatka]

Northern Dolly Varden from Chester Lake. Photo courtesy of K. McNeilly.

Description

Dolly Varden may be distinguished from the native bull trout by the following characters: when a Dolly Varden is viewed from the side the eye is well below the dorsal margin of the head, with the vertical distance from the center of the eye to the top of the head being about equal to the distance from the center of the eye to the nostril; the upper jaw is relatively straight; the head is relatively compressed when viewed from above or from the front; gillrakers long, lacking teeth in inner margin; total number of branchiostegal rays (both sides) usually 20-24 (vs usually 25-30 in bull trout). For characteristics of Arctic char, the species that was originally thought to be introduced into Chester Lake rather than northern Dolly Varden, see Appendix I.

In Chester Lake, Alberta, the gillraker count from eight fish is 19-24 (usually 22-23) and older males have a well-developed hooked snout or "kype" (K. McNeilly, personal communication).

Distribution

● Dolly Varden are native to northeastern Asia and western North America from Washington to Alaska and, in the north, east to westernmost Northwest Territories; they were probably in northern California in historic times. Dr. Robert J. Behnke recognizes two subspecies of Dolly Varden in North America; the southern one extends from

Washington to Alaska and the northern one from Kamchatka in Asia eastward through Alaska to the Mackenzie River. There are no native populations of Dolly Varden in Alberta (Haas and McPhail 1991).

■ Northern Dolly Varden were successfully introduced into Alberta in Chester Lake, west of Calgary between Lower Kananaskis Lake and Spray Lakes Reservoir and 4 km northeast of Mud Lake (see Historical Note).

Biology

Dolly Varden have anadromous and freshwater populations. They feed primarily on fish and invertebrates (usually benthic organisms). Spawning occurs in the fall with the eggs hatching in the spring.

In Chester Lake, Alberta, reproduction is occurring and growth is rapid (Ladd 1982); spawning occurs within the lake (K. McNeilly, personal communication). Spawning males are brightly colored. Cutthroat trout were introduced to Chester Lake to provide an additional food source and hopefully reduce inferred cannibalism of large Dolly Varden on small Dolly Varden as well as to provide a more diversified fishery.

Historical Note

J.J. Walbaum first described the Dolly Varden (based on descriptions of earlier workers) in 1792 from Kamchatka as *Salmo malma*. The origin of the common name "Dolly Varden" has an interesting history. Dolly Varden was a young lady in Charles Dickens' novel "Barnaby Rudge." She became a popular subject for paintings and in 1861 one of these paintings probably inspired the creation of Dolly Varden dresses which became quite fashionable. The name of the fish was first used in California because of its resemblance to the color pattern of one of the Dolly Varden dresses (Moyle 1976:145). However, as noted by Cavender (1978) and Dr. R.J. Behnke (personal communication), it may have been *Salvelinus confluentus* (bull trout) to which the name "Dolly Varden" was originally applied. Even if this is so, the use of the common names will undoubtedly remain as they are.

Northern Dolly Varden were introduced into Chester Lake on 31 August 1974. Originally it was thought that the species introduced was Arctic char, but it is now believed that the fish were northern Dolly Varden. This change in identification is the result of changes in our understanding of what should correctly be referred to as Dolly Varden or Arctic char (two highly variable species complexes) largely as a result of the research of Dr. R.J. Behnke. We hasten to stress that the change

does not represent poor identification on the part of the scientists handling the original fish; given the state of knowledge of char taxonomy in the early 1970s it was a reasonable identification to make. It was through the efforts of Kyle McNeilly, who has kindly shared with us his information on the fish that he has angled, that the identification of the Chester Lake char as northern Dolly Varden came to light (also see McNeilly 1990). As far as we know, no bull trout were present in the lake thereby excluding any possibility of the present population representing a hybrid complex.

There is some doubt about the exact origin of the stock put into Chester Lake. Eggs from two different studies were held in Calgary in 1973-74, one said to be from the Mackenzie (Inuvik stock) and the other from the Firth River; at the time it was thought that both were Arctic char. Dr. Peter J. McCart, then of Aquatic Environments Ltd., stated in early conversation with us that he had char of Inuvik stock that were originally brought to Calgary as eggs and used in one of his studies. Apparently some 1600 individuals of 10-13 cm length which remained after his studies were planted in Chester Lake by Alberta Fish and Wildlife Division rather than be destroyed. In addition, Dr. D.G. McDonald, who wrote an M.Sc. thesis at the University of Calgary in 1974, under the supervision of Dr. Brian McMahon, had developing eggs of a char. The eggs were obtained from anadromous individuals (2 females and 2 males) from the Firth River, Yukon Territory. Only a few fish were reared much beyond hatching (Dr. D.G. McDonald, personal communication). We have no evidence that suggests that these fish were the ones put into Chester Lake. It is, of course, quite possible, if not probable, that the eggs used by both McCart and McDonald came from the same source (i.e., the Firth River, then shipped to Calgary via Inuvik).

The state of char taxonomy is unsettled and more detailed studies of the sympatric occurrence of various forms and the association of these forms with originally described taxa will be required for a better understanding of what limits should be given to the names applied.

16.14 Brook Trout (or Eastern brook trout; Speckled trout) *Salvelinus fontinalis* (Mitchill)

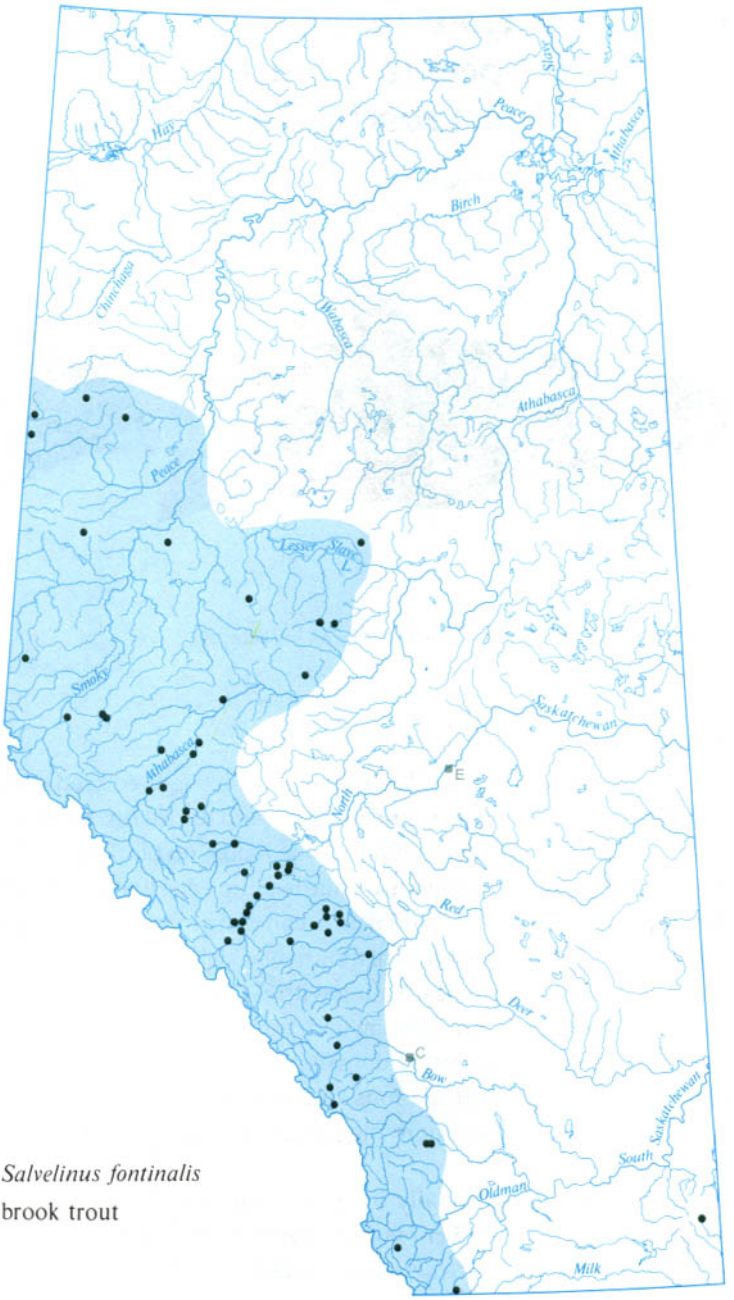
[*Salvelinus*: an old name of the char (charr); *fontinalis:* living in springs]

Brook trout, adult male from Alford Creek. M.J. Paetz.

Description

Color: Olive-green dorsally; sides lighter. Distinct light-colored worm-like vermiculations on top of head, back, and dorsal fin. Sides with red or pink spots which often have blue halos; no black spots. Pectoral, pelvic, and anal fins with a white leading edge lined with black. Few spots on edges of caudal fin, concentric bands sometimes present. Tips of jaws and roof of mouth blackish and sides and belly reddish in spawning males. Young with 7-11 broad oval parr marks along the lateral line. Small young with transparent dorsal fin, young over 5 cm long with a spotted dorsal fin, and young over 8 cm with conspicuous dark vermiculations and spots on dorsal fin. The newly hatched fry are much more pigmented than newly hatched lake trout.

Body: Upper jaw exceptionally long, extending well past posterior margin of eye even in 5 cm young. Teeth well developed, not on vomerine shaft; no space between vomerine and palatine teeth anteriorly. Tongue teeth convergent anteriorly. Basibranchial ("hyoid") teeth usually absent. Anterior tip of dorsal fin relatively rounded. Caudal fin only slightly forked. Pored scales along lateral line about



Map 16.14 Distribution of brook trout in Alberta.

109-127; scales one row above lateral line 197-243; above lateral line about 38-40; around caudal peduncle about 70-80. Principal rays in dorsal fin 10-13 and in anal fin 8-12. Gillrakers 14-22. Pyloric caeca 23-49. Vertebrae 57-62.

Size: Maximum length about 98 cm and weight about 6.6 kg.

Alberta

Vertebral number in 12 specimens from Prairie Creek is as follows: 57 in 5 specimens, 58 in 3, 59 in 1, 60 in 1, and 61 in 2 (additional counts by W.E. Roberts from Haven Creek are 57 to 59).

Maximum size noted in Alberta is 75.5 cm fork length (weight 5.9 kg) in a fish angled from Pine Lake, Wood Buffalo National Park, in 1967. Individuals of similar length are known from near Caroline.

Distribution

● Native in northeastern Manitoba, around Hudson Bay drainage to the Ungava Bay area and Newfoundland to the Carolinas and Lake Superior drainage; some Mississippi head-waters. Anadromous (sea-run) populations occur in coastal areas. Introduced throughout much of the world in temperate regions, including South America and New Zealand.

■ Brook trout are not native to Alberta but have been successfully introduced in the western half of the province in the Peace, Athabasca, North Saskatchewan, Red Deer, Bow, and Oldman river drainages (see Map 16.14). They were also introduced into Pine Lake, Wood Buffalo National Park, where for several years they provided an excellent fishery. The shaded area on the map indicates where there is active or potential stocking.

Biology

Brook trout frequent cool streams, beaver ponds, and the clear shallow areas of lakes. In most waters their diet consists mainly of caddis fly larvae, chironomids, mayflies, amphipods, and *Daphnia*. Spawning usually occurs from September to November, usually over gravel beds in shallow streams or gravelly shallow areas of lakes. An average female produces about 300-1,000 eggs each year. Hatching occurs as early as mid-February in the Clearwater system (W.E. Roberts, personal communication). Maturity is usually reached at ages 2-4. The normal maximum life span is 8 years. In Alberta streams few brook trout have been found beyond the age of 6 years, but they have been recorded up to 13 years of age in a mountain lake (Donald et al. 1980).

Brook trout and brown trout sometimes hybridize in Alberta (see Biology of brown trout, Section 16.11, for details). Hybrids between bull trout and brook trout also occur in Alberta (see Biology of bull trout, Section 16.12, for details). Artificially produced hybrids of brook trout and lake trout are called "splake" and are common in the sport fishery of the Rocky Mountain parks (see Biology of lake trout, Section 16.15). In 1962 hybrids between brook trout and Quebec red trout (see Appendix I) were stocked into Lake Louise and Bow Lake in Banff National Park and into Third Trefoil Lake in Jasper National Park. None of these hybrids are known to have survived.

Angling

Brook trout are considered to be relatively easy to catch and are a popular sport fish. They may be taken on wet or dry flies and on various types of spinning lures. The most popular stream fisheries for "brookies" are tributaries of the Red Deer and Clearwater rivers where the fish are abundant and pan size. A number of mountain lakes in Jasper and Waterton National parks as well as stocked lakes in other parts of Alberta also provide excellent angling.

Historical Note

S.L. Mitchill first described the brook trout in 1815 from near New York City as *Salmo fontinalis*. Vick (1913) and Whitehouse (1919) note the introduction of brook trout into the Banff area from Lake Nipigon stock about 1910. It was introduced into Maligne Lake, southeast of Jasper, in 1928.

16.15 Lake Trout *Salvelinus namaycush* (Walbaum)

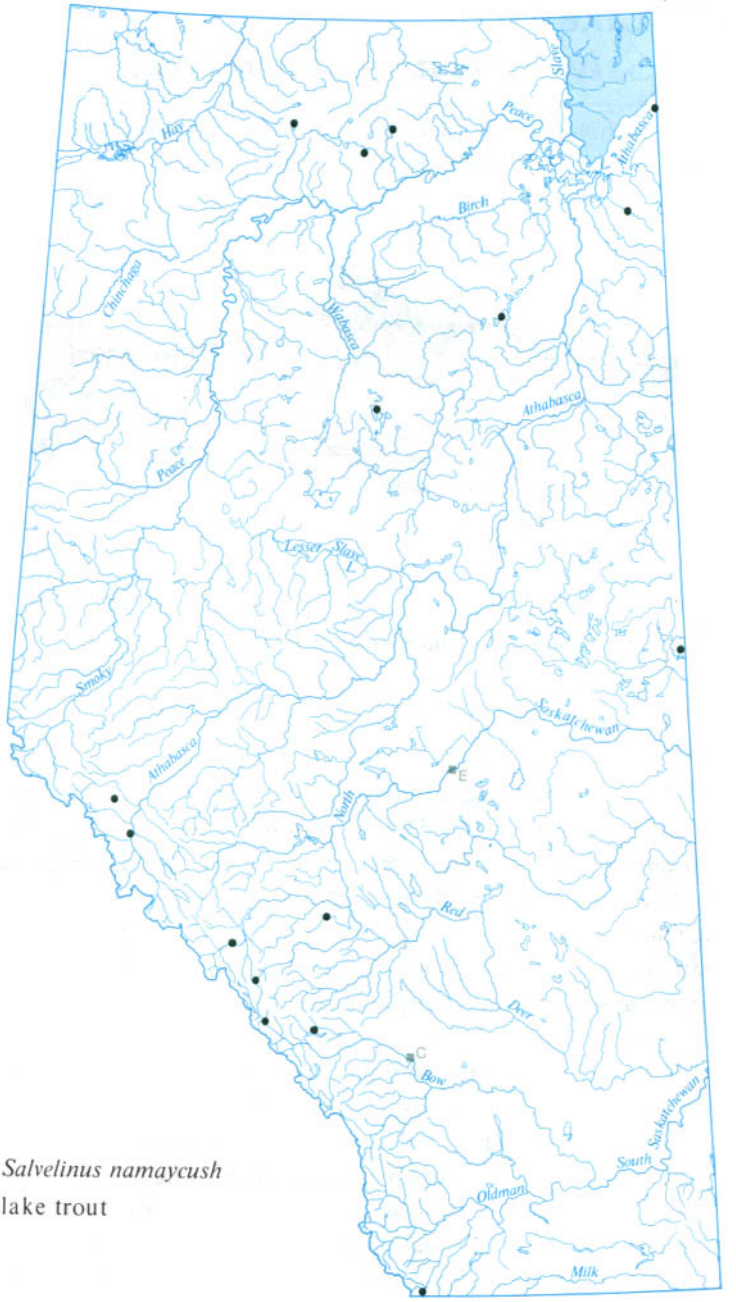
[*Salvelinus*: an old name of the char (charr); *namaycush*: an Indian name, meaning "dweller of the deep"]

Lake trout from Swan Lake. Photo courtesy of R.J. Paterson.

Description

Color: Olive to brownish-gray dorsally, sides light silvery. Faint grayish vermiculations on back and irregular grayish spots on sides. Dorsal and caudal fins with light spots but without white edging or sharply different colors. Tips of jaws and roof of mouth whitish in spawning males. Newly hatched fry very lightly pigmented, much less so than that of brook trout. Young with 8-11 elongate parr marks crossing the lateral line, fins transparent, and few or no grayish blotches or vermiculations.

Body: Upper jaw extending well past the posterior margin of eye; in young the upper jaw extends past the midline of the eye. Teeth well developed, absent from the posterior shaft of the vomer but a single row usually present on anterior shaft. Little or no space between the vomer and palatine anteriorly. Tongue teeth usually in a parallel row. Basibranchial ("hyoid") teeth well developed. Origin of adipose fin sometimes even with the hind end of the anal fin. Caudal peduncle relatively narrow compared to other salmonids. Caudal fin deeply forked. Lateral-line pored scales about 120-135; scales one row above lateral line 175-228; above lateral line about



Map 16.15 Distribution of lake trout in Alberta.

30-35; around caudal peduncle about 60. Branched dorsal and anal fin rays 8-10 (all rays 10-12). Gillrakers 17-24. Pyloric caeca 81-190. Vertebrae 61-69.

Spawning individuals usually develop small projections called "nuptial tubercles" or "pearl" organs on the scales.

Size: The world's largest lake trout was taken in the Saskatchewan portion of Lake Athabasca in 1961. It was 126 cm in total length and weighed 46.3 kg.

Alberta

Maximum lengths noted from Alberta are 76 cm fork length from Swan Lake near Rocky Mountain House (Paterson 1968), 100 cm from Pyramid Lake (Rawson and Elsey 1950), and 102 cm from Waterton Lakes (Cuerrier and Schultz 1957). Maximum weight for an angling record is 23.9 kg (length unknown) in a lake trout taken from Cold Lake in 1929 by a Mrs. Erickson. Heavier fish are reported to have been taken in the commercial fishery in Cold Lake in the 1920s.

Distribution

● Alaska to Labrador, including some Arctic Islands, and northern British Columbia as far south as the Shuswap Lake area, through the Great Lakes to Nova Scotia. This species extends farther north than any other North American salmonid except for the Arctic char.

■ Lake trout are known in Alberta and believed to be native in the Slave, Peace, and Beaver river drainages and in headwater lakes of the Athabasca (e.g., Moab, Pyramid, Rock, Graham, and Legend), North Saskatchewan (e.g., Glacier and Swan), and South Saskatchewan (e.g., Waterton and Minnewanka) river drainages (see Map 16.15). Lake trout were once present in Lesser Slave Lake but were extirpated in the 1920s, probably due to unusually heavy commercial fishing pressure. Lake trout were unsuccessfully introduced into Sylvan Lake.

Biology

Lake trout tend to be restricted to relatively deep cool lakes. In early spring when the water temperature throughout the lake is uniformly cold, individuals may be found at all depths, but as the season progresses they seek deep areas where the temperature is less than 10°C. In Alberta the diet of lake trout is quite variable. Lake trout under about 25 cm feed predominantly on chironomid larvae. Where they have the choice, such as in Lake Athabasca, Waterton Lakes, and Lake

Minnewanka, their diet as adults is primarily on other fish. Where other fish are not readily available, as in Swan Lake, good growth can occur on a diet of crustaceans and insects (Paterson 1968). However, severe stunting may occur when their preferred foods, such as amphipods and other fish, are lacking. For example, the subalpine Sassenach Lake in Jasper National Park holds the record for slow growth in lake trout—one individual was 28 years old but only 33.3 cm in length and 451 g in weight (Donald and Alger 1986b). Lake trout in Alberta spawn on rocky or gravel shoals from mid-September to October. The average female in a spawning season produces 4,000-11,000 eggs of somewhat larger size than those of brook trout. Maturity is usually reached at about age 5-10.

Lake trout and brook trout were artificially crossed in 1946 at the Banff fish hatchery and probably the first successfully reared hybrids were produced in 1947, from Lake Minnewanka and Third Vermilion Lake parents (Stenton 1950). Generally the only successful cross involves female lake trout and male brook trout. The hybrids, called "splake," are generally somewhat intermediate in most characters with their parents (Stenton 1952). Lake Agnes, near Lake Louise, has a splake population which has reproduced for several generations. Splake have been extensively introduced as a sport fish in parts of Canada, but the first introduction in Alberta outside Jasper, Banff, and Wood Buffalo (Pine Lake) National Parks was made in 1968 in the Edson area. Natural hybridization between lake trout and brook trout or between other char is not known to occur. Although not investigated in Alberta, lake trout are susceptible to parasites known in our other salmonids.

For a guide to further information on lake trout see Marshall and Layton (1985) and Marshall et al.(1990).

Angling

Lake trout are taken mainly by casting or trolling with large metal lures. In the spring they may be readily caught in shallow water but during the summer when these trout seek cool deep water, trolling at greater depths with metal lines and weighted lures is the most common method of fishing for them. Their popularity with sportsmen is due largely to the fact that they are considered as trophy fish and to their excellent table qualities. Alberta lakes frequently visited by lake trout anglers include Cold, Peerless, Margaret, Namur, and Andrew lakes.

Historical Note

J.J. Walbaum first described lake trout (based on Pennant's description) in 1792 from Hudson Bay as *Salmo namaycush*. It was first reported from Alberta by Eigenmann (1895) who obtained large *Salvelinus* from Devil's Lake (this is a former name for Lake Minnewanka), Banff National Park, up to 43 cm (reported to him to reach 100 cm). Vick (1913) noted them in Lake Minnewanka, near Banff, and Whitehouse (1919) noted them from "northern lakes of Alberta." Recorded from Lake Athabasca by Preble (1908) and Kendall (1924). Bajkov (1927) noted them to be uncommon in Jasper National Park lakes. Lake trout are placed in the monotypic genus *Cristivomer* by a few workers.

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17 Trout-Perch Family—Percopsidae

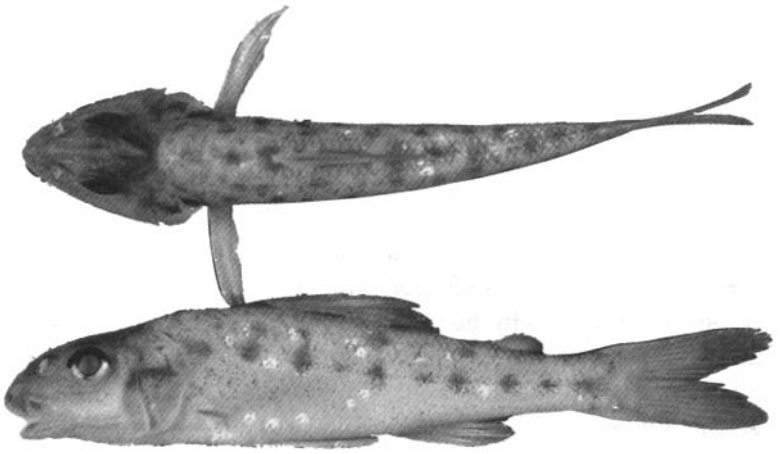
MEMBERS OF THE trout-perch family are confined to the fresh waters of North America. Two species are recognized, the sand roller (*Percopsis transmontana)* in the Columbia River System of the United States, and the trout-perch (*P. omiscomaycus*) of northern and eastern North America. Both are small fish, seldom exceeding 12 cm in length.

As the common name suggests, members of this family have some features similar to trout (e.g., one dorsal fin and an adipose fin) and some similar to that of perch (e.g., premaxilla forming entire margin of upper jaw, spines (soft) in dorsal fin, pelvic fin inserted beneath pectoral fin, ctenoid scales (weakly developed), similar number of branchiostegal rays). The closest relative of the family is the pirate perch (*Aphredoderus sayanus*), a fish in the eastern United States.

The trout-perch family is the only member of the order Percopsiformes in Canada.

17.1 Trout-Perch
Percopsis omiscomaycus (Walbaum)

[*Perc opsis*: perch appearance; *omisco maycus*: a common name, probably from the Algonquin Indians]

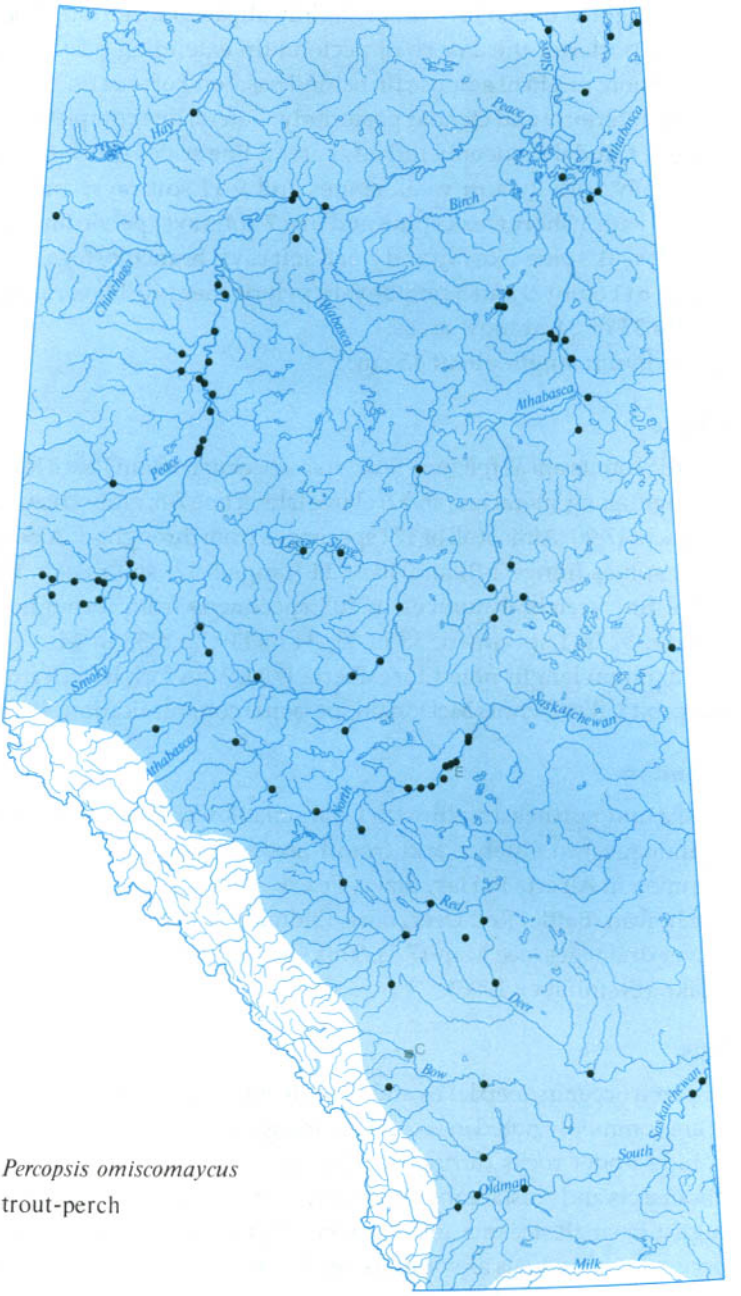


Trout-perch adults, 5.2 cm standard length from Simonette River.

Description

Color: Pale yellow and silvery, somewhat translucent in life, with 8-13 dark blotches along lateral line. Small blotches above and sometimes below lateral line. Peritoneum silvery with a few black spots.

Body: Slightly compressed, somewhat triangular in section. Head conical and slightly rounded dorsally; space between eyes about 1 1/3 times eye diameter; eyes moderate in size; mouth moderate in size (not extending back nearly as far as anterior margin of eye) and slightly subterminal; upper lip not separated from snout by a continuous groove (narrow frenum present); front margin of snout rounded. Extremely small teeth in bands confined to premaxillae and lower jaw. Gill membranes extending forward and very narrowly joined, if at all, to each other and to the isthmus. Gillrakers short and stumpy, 2-4 on upper arch and 6-9 on lower arch (total usually 9-12). Pectoral fin base oblique (almost at a 45 angle) and on lower half of



Map 17.1 Distribution of trout-perch in Alberta.

body. Origin of dorsal fin over or slightly ahead of insertion of pelvic fins; posterior third or so of pectoral fin extending past pelvic fin insertion; origin of adipose fin behind basal end of anal fin. Scales cycloid anteriorly and ctenoid posteriorly. Lateral line complete and straight. Caudal fin deeply forked. Lateral-line scales 44-55; dorsal fin usually with 2 short weak spines and 9-11 soft rays; anal fin usually with 1 short weak spine and 6 or 7 soft rays; pelvic fin with 1 small weak spine-like ray and 7 or 8 soft rays; branchiostegal rays usually 6 (1 epihyal and 5 ceratohyal); pyloric caeca 10-14; vertebrae usually 33 or 34 in most areas.

Size: Maximum length about 15 cm.

Alberta

Meristic counts are as follows. Scales (six specimens from Peace River drainage) along lateral line 46-52; above lateral line 7-8; around caudal peduncle 17-20. Almost all of 177 specimens from throughout Alberta had 2 spines (range 1-3) and 10 or 11 (range 8-12) soft rays in the dorsal fin. Vertebral number in 207 specimens from throughout Alberta: 32 in 1 specimen, 33 in 43, 34 in 119, and 35 in 44.

Maximum length noted for Alberta is 11.9 cm fork length from Sturgeon Lake (Dennis McDonald, personal communication, 1973).

Distribution

● Alaska and northeastern British Columbia (lower Peace and Liard river drainages) to Quebec and from Kansas to West Virginia.

■ Common in Alberta in Hay, Slave, Peace, Athabasca, Beaver, North Saskatchewan, Battle, Red Deer, Bow, Oldman, and South Saskatchewan river drainages (see Map 17.1). This species is also present in Bistcho Lake (Steinhilber 1988).

Biology

Trout-perch occur in deep lakes and slow rivers. Inshore movements at night are commonly noted in lakes. Like many species of small fish they often hide under rocks during the day. Their main food consists of aquatic insects and crustaceans. Spawning is thought to occur from May to August in small streams and along beaches of lakes. Some spawning occurs in individuals as young as age 1. They live as long as 4 years. In Manitoba, individuals have been found to harbor the larval stage of the tapeworm *Triaenophorus stizostedionis*, which occurs in walleye in the adult stage. Trout-perch are a common forage fish.

Although widespread in Alberta, we know virtually nothing of its biology within the province; most of our knowledge is based on studies conducted on populations from Lake Erie, Heming Lake (Manitoba), and Minnesota.

Historical Note

J.J. Walbaum (through T. Pennant) first described the trout-perch in 1792 from specimens collected in the Hudson Bay area as *Salmo omiscomaycus* (originally not in binomial form, however; first description of species in 1784). It was first reported in Alberta by Eigenmann (1895) at Medicine Hat as *Percopsis guttatus*. No other early reports exist.

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18 Cod Family—Gadidae

MEMBERS OF THE cod family are found in the fresh waters of North America and Eurasia and in marine waters of North and South America, Eurasia, Africa, and New Zealand. Their greatest abundance occurs in the North Atlantic Ocean. Most species live near the substrate. The family contains about 55 species. The burbot is the only gadid confined to fresh water, although the normally marine Atlantic tomcod enters fresh water in many areas along the east coast of North America and rarely is resident in lakes in eastern Canada. Many of the marine species constitute an important commercial group (e.g., Atlantic cod, haddock, hakes, and pollock). Unlike the freshwater burbot which has 2 dorsal and 1 anal fin, most marine forms have 3 dorsal and 2 anal fins. Most species have a single median chin barbel and small scales.

The burbot is the only member of the order Gadiformes in Alberta. It is sometimes incorrectly referred to in Alberta as "catfish" (no doubt because of the barbel) or "lingcod." The latter name might seem appropriate since one of its informal names is "ling" and it is a member of the cod family; however, "lingcod" is the accepted common name for a large unrelated fish, the greenling (Hexagrammidae) *Ophiodon elongatus*, in the northern Pacific Ocean.

18.1 Burbot (or Maria; Ling; Loche) *Lota lota* (Linnaeus)

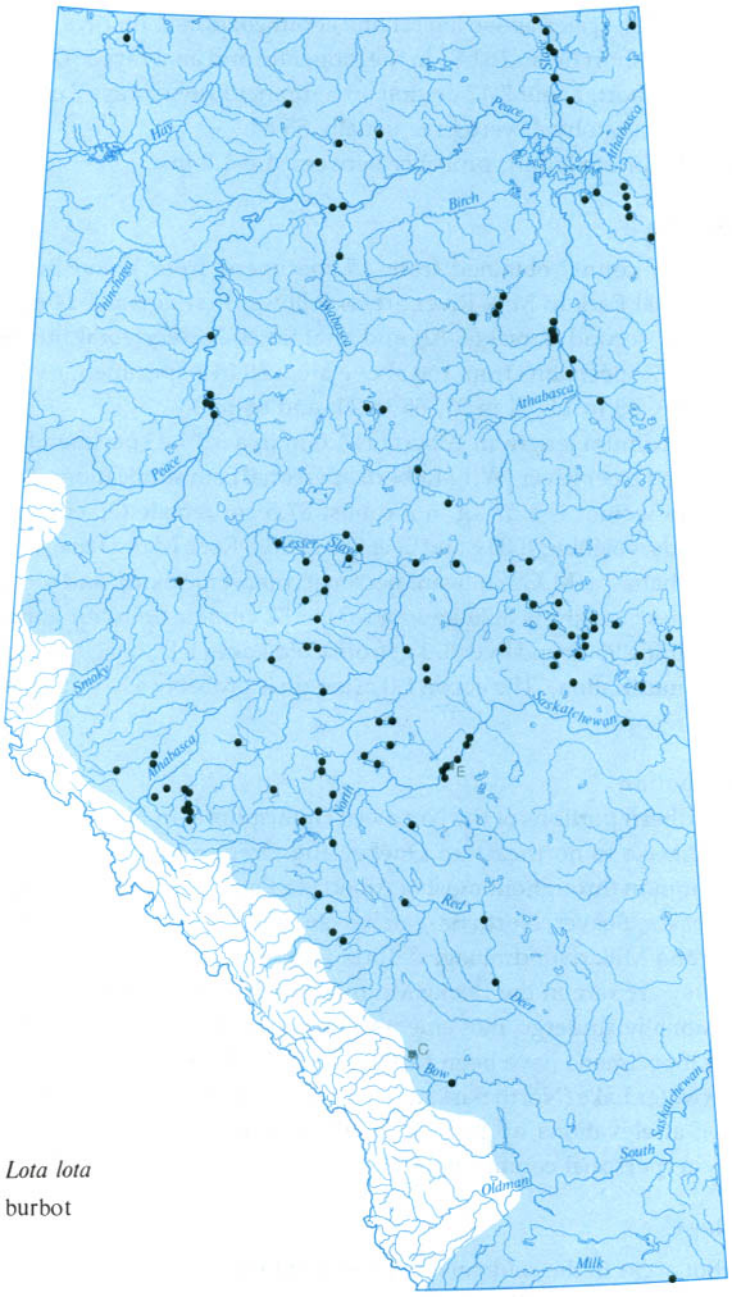
[*Lota*: from an old French name (Lotte) used by the 16th century French zoologist G. Rondelet]

Burbot from Sherburn Reservoir. M.J. Paetz.

Description

Color: Dark olive-brown dorsally with darkish markings on back, sides, and median fins (most pronounced on young). Yellow or dusky below. Peritoneum silvery with some black spots occasionally present.

Body: Rounded in section and very elongate. Head broad and flattened dorsally; space between eyes about 2 to 3 1/2 times eye diameter; eyes moderate in size; mouth wide (wider than distance between eyes and extending as far or almost as far back as the anterior margin of eye) and very slightly subterminal (upper jaw only slightly projected forward beyond the lower jaw); one long median barbel under lower jaw, one short barbel at each anterior nostril (the only other fishes in Alberta with barbels are the lake sturgeon, stonecat, and some minnows); lips fleshy, upper lip separated from snout by a complete groove. Teeth numerous, short, and in bands; on premaxillae, head of vomer, and lower jaw. Gill membranes extending forward and broadly joined to each other. Pectoral fin base almost vertical and located half way up body. Second pelvic fin ray elongated. Pelvics far forward, their insertion lying in front of the pectoral fin base. Body and most of head covered with very small cycloid scales that often require microscopic examination to see; body superficially appears naked. Lateral line complete (but often faint) and oblique. Caudal fin strongly rounded. Scales along lateral line



Map 18.1 Distribution of burbot in Alberta.

about 220; scales above lateral line about 26; dorsal fin rays 7-15 in the first short fin and 61-85 in the longer fin and anal rays 55-78; gill-rakers short, about 7-12 on first arch; branchiostegal rays 7 or 8, all on the ceratohyal; vertebrae usually 55-64.

Size: Maximum length probably between 1.0-1.2 m.

Alberta

Fin ray counts obtained from 45 specimens from Wood Buffalo National Park to Milk River are as follows: first dorsal 7-14 (most 10-12); second dorsal 66-82; and anal fin 60-78. Vertebral number from 77 specimens from the above area: 60 in 1 specimen, 61 in 2, 62 in 6, 63 in 14, 64 in 31, 65 in 20, and 66 in 3.

Maximum length in Alberta is 1.0 m in a 6.1 kg specimen from the Red Deer River (W.E. Roberts, personal communication). Maximum weight is 8.57 kg in a robust 87.5 cm female (55 cm girth, gonads weighing 1080 g and liver 780 g) from Rock Island Lake, north of Athabasca (M.G. Sullivan, personal communication), and second heaviest weight is 8.26 kg in a robust 87 cm female (with gonads weighing 950 g and liver 673 g) from Cold Lake (T.D. Boag, personal communication). The above 1.0 m length is probably a North American record.

Distribution

● Northern portions of the Northern Hemisphere. In North America from Alaska to northeastern Quebec and Oregon to Missouri.

■ Common throughout most of Alberta in Petitot, Hay, Slave, Peace, Athabasca, Beaver, North Saskatchewan, Battle, Red Deer, Bow, Oldman, and Milk river drainages. Burbot occur in some foothill streams but they are rare in the Rocky Mountains, although individuals may occasionally undergo movements into mountain streams (see Map 18.1). Specimens have been captured in the Clearwater River above Clearwater Lake (North Saskatchewan River drainage, Banff National Park), at elevations up to 1,925 m above sea level (T. Hurd and K. Brewin, personal communication).

Biology

Burbot occur in the cold parts of lakes and in large and small streams. Their main food consists of fish and aquatic insect larvae, but they also have been found to prey heavily on whitefish eggs. Burbot appear to be unique among Alberta fish in growing faster during the winter than

during the summer after age 3 when they reach reproductive maturity; juveniles grow faster in the summer than in the winter as is true for other species of fish in Alberta. However, the winter growth in the mature fish, although faster than that during the summer, is relatively slow such that, again apparently unlike in other Alberta fishes, there is very little growth after they are mature even though they may live another 10 or more years (T.D. Boag, personal communication; Boag 1989). They spawn during the winter and early spring from January to April (usually in February and March). Spawning has been noted by T.D. Boag over sand substrates in water less than 2 m deep. Maturity is normally reached in their third year. Large females may contain over 1,000,000 eggs.

Angling

Although the burbot is not generally recognized as a sport fish in Alberta, it is likely to gain increased acceptance as pressure on traditional species increases and as people come to know and appreciate its table qualities. Currently, most burbot are taken by anglers incidentally while in pursuit of other game fish such as pike and walleye. Burbot are seldom eaten, but when they are skinned it is a tasty fish that is relatively free of dangerous bones. The liver is extremely high in vitamin A and D and is comparable with medicinal liver oil from Atlantic cod. Burbot can be caught in most of our medium and large rivers and in many lakes. They are most frequently taken on baited hooks but may also be taken on non-baited lures or flies.

Historical Note

C. Linnaeus first described the burbot in 1758 from Europe as *Gadus lota*, although it was well known before that time. It was first mentioned to be in Alberta by Eigenmann (1895) on reports from Calgary. Whitehouse (1919) noted it from Sylvan Lake, Red Deer River, and Peace River as *Lota maculosa*.

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19 Livebearer Family—Poeciliidae

POECILIIDS ARE NATIVE to the New World from the eastern United States to northeastern Argentina; they are limited to low elevations in fresh and brackish waters. There are about 150 species. Livebearers are common aquarium fishes (e.g., guppy, molly, platyfish, swordtail) and various species have been introduced into streams and lakes around the world. They seldom get over 12 cm in length. Two species are established in Alberta in hotsprings near Banff at an elevation of about 1380 m. The introduction of these two species, one made by the federal government and the other illegally by a local aquarist, is unfortunate. The introduction of such exotics seriously endangers native populations of other species, both invertebrates through predation and other fishes through predation, competition, and aggressive interactions.

As the common name suggests, members of this family bear free-swimming young (except in one species). Internal fertilization is possible with the male gonopodium, a structure formed by an elongation of the anterior anal fin rays. In all other fish species in Alberta eggs and milt are released into the water and fertilization is external.

Poeciliids may be distinguished from killifishes (e.g., *Fundulus*) and other related families in having the first 3 anal fin rays unbranched.

Key to the 2 Species

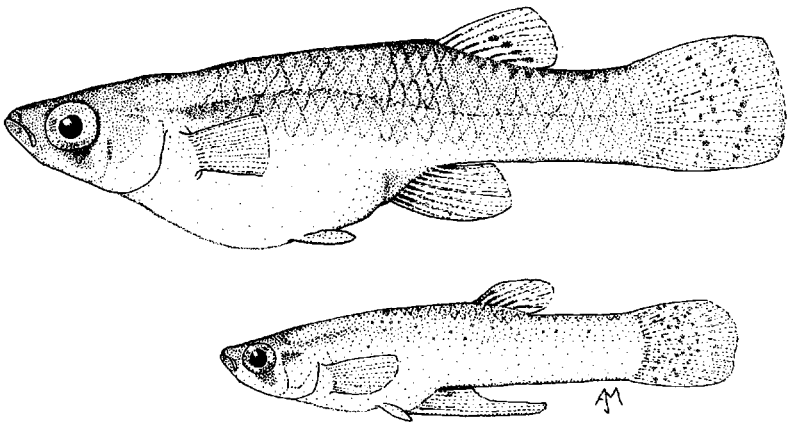
Use the following key to identify a species in the livebearer family. For an explanation of how to use the key, see section 7.2.

1A Dorsal fin rays 5-7; 29-33 rows of scales in lateral series; color usually pale to light brown..... .....**Western mosquitofish—*Gambusia affinis*.**
SEE SECTION 19.1.

1B Dorsal fin rays 12-15; 25-28 rows of scales in lateral series; color in Alberta variable, usually pale with several rows of dark spots along body but can also have irregular dark markings, be jet black, or be a uniform light brown or yellow..... .....**Sailfin molly—*Poecilia latipinna*.**
SEE SECTION 19.2.

19.1 Western Mosquitofish *Gambusia affinis* (Baird and Girard)

[*Gambusia*: from a Cuban word meaning "nothing"; *affinis*: in reference to being related to another species]



Mosquitofish from the Cave and Basin marsh, Banff. Female, 3.8 cm standard length (top) and male, 2.4 cm standard length (bottom). Note difference in anal fin shape and position.

Description

Color: Pale yellow to yellowish-brown with dark pigment around border of scales. Dark stripe extending along center of back from just behind head to origin of dorsal fin and dusky patch below eye. Rows of black spots on caudal and dorsal fins and occasionally on body.

Body: Slender (males) to plump (females); hind portion compressed. Head flattened dorsally; mouth supraterminal (lower jaw extends forward past upper jaw and mouth opens dorsally) and oblique when viewed from the side. Continuous groove separating the protractile upper lip from snout. Gill membranes extending far forward. Pectoral fin base almost vertical. Pelvic fin insertion near tip of extended pectoral fin in females and near mid-portion of pectoral fin (i.e., farther forward) in males. Origin of dorsal fin about even with or slightly in front of insertion of anal fin in females, but in males

it is well behind. Caudal fin rounded. Lateral-line canal and pores absent on body. Scales on top of head and on cheeks.

Size: Maximum length about 7 cm (females).

Alberta

Meristic counts obtained from 35 specimens from the Cave and Basin marsh are as follows. Scales on body in 29-33 lateral rows. Dorsal fin rays 5-7 (usually 6) and anal fin rays 8-10 (usually 9). Vertebral number: 31 in 1 specimen, 32 in 23, and 33 in 11.

Maximum length in Alberta is 4.4 cm for females and 2.8 cm for males.

Distribution

● Native to drainages of the Gulf of Mexico from central Mexico to Florida, from coastal brackish water areas and inland to Illinois, and north along the Atlantic coast to New Jersey. In addition, mosquitofish have been widely introduced throughout the world in warm waters.

■ Known in Alberta only from the Cave and Basin Hot Springs area near Banff. They are found in the marsh area and in some of the springs, particularly Basin Spring; they are also possibly in Third Vermilion Lake.

Biology

Mosquitofish are the most abundant species in the Cave and Basin Hot Springs drainage (Nelson 1983). They have a relatively wide temperature tolerance and occur in springs flowing into Cave and Basin marsh in water as warm as 30°C and have been seen under ice in the marsh in winter. They are a very aggressive fish and have a detrimental effect on other small fish. They may have contributed to the extinction of several fish species in various parts of the world. They do eat mosquito larvae but appear not to have caused the extinction of any species of mosquito! This and the sailfin molly are the only two livebearing species in Alberta, and females at Cave and Basin have been found with up to 70 developing eggs. The mosquitofish near Banff occur at an unusually high elevation and northern latitude. Most reproduction occurs in late spring and the summer. They go through a markedly different photoperiod at the latitude of Banff than found in their natural range. This species has been subject to many behavioral studies elsewhere. They can be readily observed in Cave and Basin from a viewing platform built by Parks Canada which extends into the marsh.

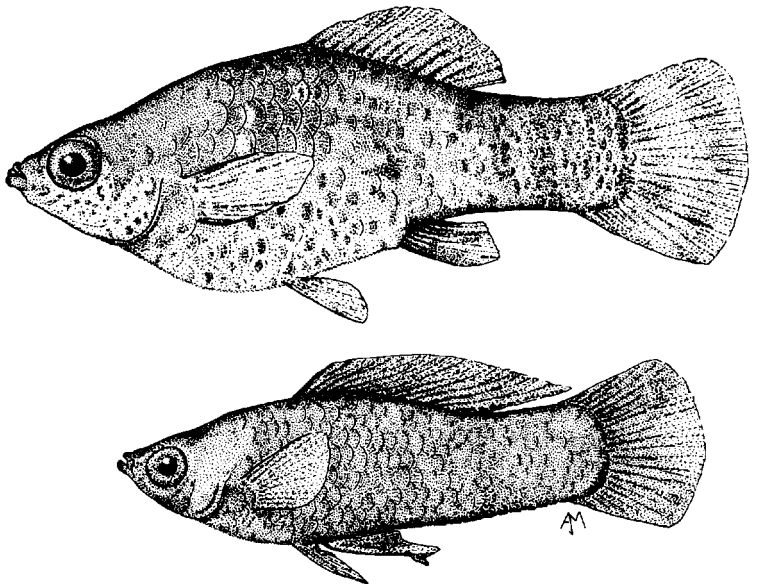
Two subspecies have usually been recognized. The subspecies in Alberta seems to be *G. affinis affinis*, native to Gulf of Mexico drainages (Nelson 1983). It has on average one less ray in the dorsal and anal fins and less pigmentation than the form occurring from central Alabama eastward to along the Atlantic coast. However, in Wooten et al.,(1988) evidence was given that strongly suggests that these two forms should be recognized as different species. The Alberta species would remain *G. affinis*.

Historical Note

S.F. Baird and C. Girard first described the western mosquitofish in 1853 from Texas as *Heterandria affinis*. The mosquitofish was introduced into the Cave and Basin area from California in 1924 by the federal government in order to control mosquitos around the hotspring bathhouse area (Mail 1954).

19.2 Sailfin Molly *Poecilia latipinna* (Lesueur)

[*Poecilia:* variegated (in color pattern); *lati pinna:* broad fin]



Sailfin molly from the Cave and Basin marsh, Banff. Female, 3.9 cm standard length (top) and male, 3.1 cm standard length (bottom). Note difference in anal fin shape and position.

Description

Color: Highly variable; in the Cave and Basin marsh in 1981 the jet black form was commonest but the checkered black, marbled black, and golden (very rare) forms were also present. In 1988 the checkered black form (with several rows of black spots along the body) was commonest with the jet black and golden forms being very rare.

Body: Plump to moderately compressed. Head flattened dorsally; mouth supraterminal (lower jaw extends forward past upper jaw and mouth opens dorsally), mouth very short in length (much shorter than in mosquitofish). Continuous groove separating the protractile upper lip from snout. Gill membranes extending moderately far forward, connected to one another. Pectoral fin base almost

vertical. Pelvic fin insertion beneath hind portion of extended pectoral fin in females and beneath front portion in males (the pelvic and anal fins of males are farther forward than those of females; the latter two fins overlap one another in males but not in females). Origin of dorsal fin in females about even with or slightly behind insertion of pelvic and far forward of anal fin origin, but in males the origin of the dorsal fin is about even with the anal fin origin. Caudal fin rounded. Lateral-line canal and pores absent on body but many scales in the dorsal and ventral regions have a microscopic depression near the focus (this is the pit organ or neuromast). Scales on head.

Size: Maximum length about 13 cm (females).

Alberta

Meristic counts obtained from 24 specimens from Cave and Basin marsh are as follows. Scales on body in 26-28 lateral rows. Dorsal fin rays 12-15 and anal fin rays 7-9. Vertebral number: 27 in 3 specimens, 28 in 6, and 29 in 15.

Maximum length in Alberta is 5.0 cm for females and 3.3 cm for males.

Distribution

● Native to drainages of the Gulf of Mexico from Yucatan Peninsula to Florida and north along the Atlantic coast to North Carolina in habitats along protected coastlines and a short distance inland. Introduced into part of the southwestern United States and several other parts of the world either for mosquito control or from aquaria releases.

■ Known in Alberta only from the Cave and Basin Hot Springs marsh.

Biology

Sailfin molly are common in the warm parts of the marsh of Cave and Basin Hot Springs (Nelson 1983). The enlarged dorsal fin, giving rise to the common name, develops only in relatively large males. Apparently the originally introduced black form has reverted to other color morphs including the presumed wild-type (checkered pattern); in 1981 the black form was still dominant but in 1988 the checkered pattern predominated (it is unfortunate that we do not have a yearly sample to know more about the change in frequency of the color morphs). In a small sample of fish from the Cave and Basin marsh, individual females of this livebearing species had up to 60 developing eggs.

Historical Note

C.A. Lesueur first described the sailfin molly in 1821 from Louisiana as *Mollienesia latipinna*. It was first recorded in Alberta by McAllister (1969). Several pairs of all-black (permablack) forms were introduced into Cave and Basin marsh in 1960 by a local aquarist.

20 Stickleback Family—Gasterosteidae

STICKLEBACKS OCCUR IN fresh water and along coastlines in the Northern Hemisphere. Some coastal members are anadromous, spawning in fresh water but spending much of their life in the ocean, while others are fully marine. The family contains five genera and about eight species (including two species complexes—a species complex is a taxon consisting of two or more forms each of which has some attributes of a biological species but that, for various reasons, is difficult to classify to species in conventional taxonomy). Five named species occur in Canada; of these there are two native and one introduced species in Alberta (two in British Columbia; three in the Northwest Territories; and two in Saskatchewan). Some other stickleback populations in Canada may warrant description as a new species.

Sticklebacks are small fish, seldom getting over 8 cm in North America. They spawn in the spring and early summer. They have been extensively studied by zoologists, especially the threespine stickleback (*Gasterosteus aculeatus*). In particular, their nest building activity for reproduction has received much attention. The male builds a nest made of algae and other aquatic plants. He secretes a thread-like sticky mucus produced in the kidney that acts as a glue to hold the nest materials together. Depending on the species, the nest may be built into the substrate, as in the threespine stickleback, or be attached to something like a log or rooted aquatic plant and be off the substrate, as in our native species. When the nest is completed the male will lead a female into the nest where the eggs are laid and fertilized. The male then guards the nest, fans the eggs with his pectoral fins to provide the developing embryos with sufficient oxygen, and cares for the young for a short while after they hatch. Much effort has been directed at studying the

evolutionary adaptation of various morphological characters such as the dorsal spines and lateral bony plates, especially in response to predation.

All sticklebacks have a series of isolated spines preceding the soft dorsal fin, paired pelvic spines (see description of *Culaea* and *Pungitius* for exceptions), a single spine in the anal fin, and 3 branchiostegal rays (1 epihyal and 2 ceratohyal).

Sticklebacks are closely related to the marine tubesnouts, the Aulorhynchidae, a small coastal group in the North Pacific Ocean, and both are usually placed in the order Gasterosteiformes.

Key to the 3 Species

Use the following key to identify a species in the stickleback family. For an explanation of how to use the key, see Section 7.2.

1A Isolated dorsal spines 7-11, some inclined to the right and some to the left; caudal peduncle wider than deep, with a lateral keel; caudal fin posterior margin concave..... **Ninespine stickleback—*Pungitius pungitius*.** SEE SECTION 20.2.

1B Isolated dorsal spines 3-6 (rarely 7), in a vertical line; caudal peduncle deeper than wide, without a lateral keel in Alberta specimens; caudal fin posterior margin straightish or rounded (convex)..... GO TO 2A AND 2B.

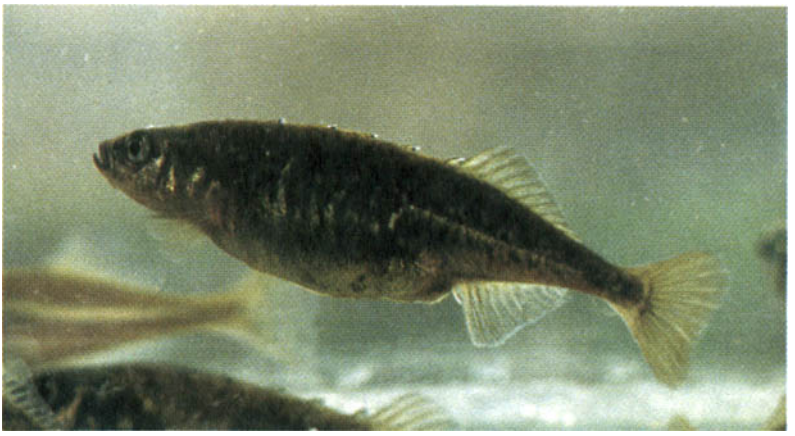
(FROM 1B)

2A Dorsal spines usually 4-6 (rarely 7); spines short, longest dorsal or pelvic spine shorter than eye diameter; no distinct bony plates on side of body..... **Brook stickleback—*Culaea inconstans*.** SEE SECTION 20.1.

2B Dorsal spines usually 3; longest dorsal spine and pelvic spine longer than eye diameter; conspicuous bony plates on side of body in region of pectoral fin..... **Threespine stickleback—*Gasterosteus aculeatus*.** SEE SECTION 20.3.

20.1 Brook Stickleback *Culaea inconstans* (Kirtland)

[*Culaea*: a name coined in 1950; *inconstans*: variable, referring to the number of spines and rays]

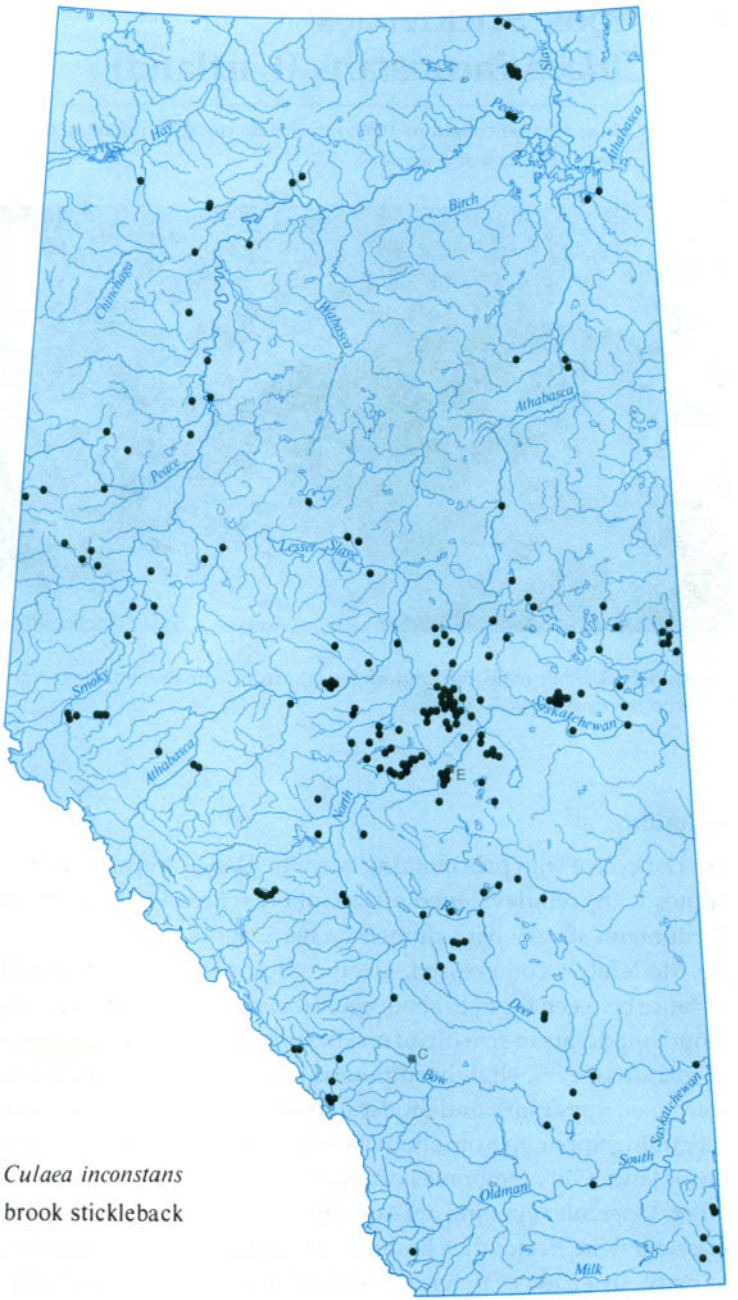


Brook stickleback adult male, 5.0 cm fork length, from Ghostpine Creek, April 1990. Photo courtesy of W.E. Roberts.

Description

Color: Dark olive with pale mottling laterally. Dorsal and anal fin membranes with well-developed melanophores. Breeding males black. Peritoneum silvery with numerous black spots.

Body: Moderately compressed. Head conical and flattened dorsally; distance between the eyes about equal to diameter of eyes; eyes large; mouth moderate in size (tip of maxilla not quite extending to anterior margin of eye), slightly supraterminal (lower lip projecting forward past upper lip), and moderately oblique. Continuous groove separating upper lip from snout. Teeth small, confined to upper and lower jaws. Gill membranes extending forward and joined to each other. Opercular opening not extending distinctly above upper edge of pectoral fin. Pectoral fin base almost vertical, mostly on lower half of body. Insertion of pelvic spines under front half of pectoral fin; the majority of individuals in many populations in Alberta lack the pelvic skeleton, including the 2 spines. Lateral line complete and with a row of 30-36 small circular bony scutes (visible only when



Map 20.1 Distribution of brook stickleback in Alberta.

stained). Caudal peduncle deeper than it is wide. Caudal fin slightly rounded (convex). Series of 4-7 (usually 5 or 6) isolated spines in a vertical line (non-divergent with one another) in front of the soft dorsal fin. Dorsal fin soft rays 8-13 and anal fin with 1 short spine and 7-12 soft rays. Gillrakers 10-15.

Size: Maximum length 8.7 cm fork length (from Astotin Lake, Elk Island National Park, Alberta).

Alberta

Meristic counts obtained from 302 specimens collected in 1986 from Astotin Lake, are as follows. Dorsal spines: 4 in 3 specimens, 5 in 216, and 6 in 83. Vertebrae: 30 in 3 specimens, 31 in 7, 32 in 98, 33 in 182, and 34 in 12.

Distribution

● Lower Peace River system of British Columbia and scattered localities in Mackenzie drainage in the Northwest Territories to New Brunswick and Nebraska to Maine; northeastern New Mexico.

■ Widespread in Alberta from Hay, Slave, Peace, Athabasca, North Saskatchewan, Beaver, Red Deer, Bow, Oldman, South Saskatchewan and Milk river drainages (see Map 20.1).

Biology

Brook stickleback occur in small clear streams, bogs, beaver ponds, and lakes. It is the most abundant fish in many small lakes and ponds and is frequently associated with the fathead minnow. Individuals of these two species have a high tolerance to low oxygen concentration and they often occur in areas where other fish can not survive. Tornado rain storms in Alberta have been reported to deposit this fish in large numbers in farmers fields (Miller 1962:169-170); however, brook stickleback often swim up the slightest run-off in springtime and the possibility exists that they disperse into fields after heavy rainstorms where they may be left stranded. Interestingly, brook stickleback have been obtained from an artesian well in Alberta. Sometime between 1945-1960, individuals were obtained when a seismic crew struck underground water north of Gull Lake near the Crestomere school which is near Highway 53 (Mrs. H. Gee, personal communication). This is probably the record referred to by Miller (1962:168-169), who also states that he has received authentic reports of their appearance in other wells and artesian water flows. These reports suggest that brook stickleback

occasionally occur in underground streams (see also Nelson and Paetz 1974).

Brook stickleback feed primarily on small aquatic insects and crustaceans. Adults occur close to or within aquatic vegetation and tend to be highly territorial during the spawning season. Young and adults in Alberta have been observed in schools in the summer. Spawning takes place in late spring and early summer. The male builds a nest about 2 to 3 1/2 cm in diameter, primarily composed of algae and leaves of rooted aquatic plants, and held together by a thread-like substance secreted from the kidney. The nest is built on rooted aquatic plants or submerged tree branches and is guarded vigorously by the male from the time a female lays her eggs until the young hatch and swim away in a few weeks. Nests can be easily observed along the shoreline of many Alberta lakes and streams between late May and early July.

Many populations are heavily infected with larval tapeworm of the genus *Schistocephalus* in the body cavity which may account for more than 1/3 of the fish's weight. Brook stickleback are subject to predation by aquatic insects (e.g., larvae of the water beetle and dragonflies), other fishes, birds such as grebes and loons, tiger salamanders, garter snakes, and mammals such as muskrats (Dekker 1976) and water shrews (study of W.E. Roberts).

The pelvic skeleton including its 2 spines does not develop in a high proportion of individuals (20% to over 99%) at about 40 localities in Alberta in the regions of Edmonton, Grande Cache, Nordegg, Bonnyville, and Wood Buffalo National Park (Nelson 1969, 1977; Nelson and Atton 1971; Nelson and Paetz 1972, 1974; Reist 1981). This phenomenon is most common in lakes lacking an outlet or in small creeks. Although there are a few localities elsewhere in Canada (e.g., Saskatchewan and Ontario) where brook sticklebacks fail to develop the pelvis, this phenomenon is most common in Alberta. The presence or absence of a pelvic skeleton with spines is at least partly under genetic control (Nelson 1977), but much remains to be known about the significance of this feature to the stickleback. It is suspected that the proportion of sticklebacks without a pelvic skeleton at a given locality may depend upon the type of predators that are present. Small northern pike seem to prefer to eat sticklebacks without pelvic spines (although in one lake large northern pike preferred to feed on sticklebacks with the pelvic spines). There is some evidence that water beetles may prefer to eat sticklebacks with pelvic spines and five dorsal spines (Reist 1980a, b; 1983).

Historical Note

J.P. Kirtland first described the brook stickleback in 1841 from Ohio as *Gasterosteus inconstans*. It was first reported in Alberta by Eigenmann (1895) at Calgary as *Eucalia inconstans*. The generic name *Culaea* was coined in 1950 after it was discovered that the name *Eucalia*, applied to the fish in 1876, had been given earlier to a butterfly.

20.2 Ninespine Stickleback *Pungitius pungitius* (Linnaeus)

[*Pungitius:* pricking]

Ninespine stickleback from Amisk Lake,Beaver River drainage. Photo courtesy of W.E. Roberts.

Description

Color: Pale green or gray dorsally, silvery to pale yellow with darkish bars laterally, silvery ventrally. Dorsal and anal fin membranes with few or no melanophores. Breeding males with black breast and white pelvic fin membranes. Peritoneum silvery with few to many black spots.

Body: Moderately compressed. Head conical and flattened dorsally; distance between the eyes about equal to eye diameter; eyes large; mouth moderate in size (tip of maxilla not quite extending to anterior margin of eye), slightly supraterminal (lower lip projecting forward past upper lip), and moderately oblique. Continuous groove separating upper lip from snout. Teeth small, confined to upper and lower jaws. Gill membranes extending forward and joined to each other. Opercular opening extends distinctly above upper edge of pectoral fin. Pectoral fin base almost vertical, mostly on lower half of body. Insertion of pelvic spines under anterior half of pectoral fin; pelvic spines may be absent in individuals from Wood Buffalo National Park. Lateral line complete and with 6-16 bony scutes on the caudal peduncle, a few scutes are occasionally present behind the pectoral skeleton. Caudal peduncle wider than it is deep, lateral

Map 20.2 Distribution of ninespine stickleback in Alberta.

keel along caudal peduncle. Caudal fin somewhat lunate (concave). Series of 7-11 isolated dorsal spines in front of the soft dorsal fin, some inclined to the left and others to the right of the midline (very rarely 6 outside Alberta, mean of 9 or 10 in Alberta lakes with most specimens having 8-10). Dorsal fin soft rays 8-11 and anal fin with 1 spine and 6-10 soft rays. Gillrakers 11-15. Vertebrae 31-35.

Size: Maximum length 7 1/2 cm.

Alberta

Meristic counts have been obtained from 176 specimens from throughout northern Alberta as follows. Dorsal spines: 8 in 17 specimens, 9 in 106, 10 in 50, and 11 in 3. Vertebrae: 32 in 13 specimens, 33 in 96, 34 in 59, and 35 in 8.

Maximum length observed for Alberta is 6 1/2 cm fork length from Pine Lake in Wood Buffalo National Park, and Cold Lake.

Distribution

● Circumpolar in the Northern Hemisphere from tidal and inland waters. Ranges in North America along the northern coastline from the Aleutian Islands to New Jersey; penetrates inland from Fort Nelson, British Columbia, to western Quebec and extends south to Minnesota and northern Indiana.

■ Known in Alberta from Petitot, Hay, Slave, Peace, Athabasca, and Beaver river drainages (see Map 20.2).

Biology

Ninespine stickleback occur in streams, lakes, and coastal marine water. In Alberta, this species occurs only in deep cold lakes and their tributaries. They feed predominantly on small aquatic insects and crustaceans. Adults do not have as strong an affinity for rooted aquatic plants as do the adults of the brook stickleback. They tend to school in open water, often in deeper zones.

About 20% of the ninespine stickleback in Pine Lake and the Salt River in Wood Buffalo National Park lack both pelvic spines (Nelson 1971; Nelson and Paetz 1972, 1974). In nearby Fox Holes Lake, a series of small ponds west of Fort Smith in the Northwest Territories, no specimens have been found that possess both pelvic spines; the majority of individuals lack all trace of the pelvic skeleton.

In lakes such as Cold Lake this is an exceedingly important forage fish for birds and fish such as northern pike, lake trout, and burbot

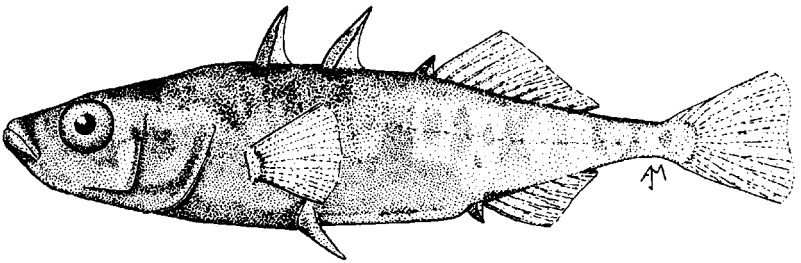
(Roberts 1975b). Leong (1975) gives a list of the parasites found in ninespine stickleback from Cold Lake.

Historical Note

C. Linnaeus first described ninespine stickleback in 1758 from Europe as *Gasterosteus pungitius,* although it was well known before that time. It was first collected in Alberta by R.B. Miller and M.J. Paetz in Cold Lake on 2 September 1952.

20.3 Threespine Stickleback *Gasterosteus aculeatus* Linnaeus

[*Gaster osteus:* stomach bone; *aculeatus:* spined]



Threespine stickleback from Hasse Lake, 4.9 cm standard length.

Description

Color: Greenish on back and upper sides and silvery on lower sides and belly; variable pattern of dark markings interspaced with white areas on side. The brilliant red belly commonly observed in spawning males has not been observed in Hasse Lake.

Body: Individuals of this species in Alberta differ from the brook and ninespine stickleback in having the following features: usually 3 dorsal spines, the first 2 isolated and long (length about 1/3 that of head length), the last one relatively short and immediately preceding the soft dorsal fin; usually 5-9 bony plates on the side.

Size: Maximum length slightly over 10 cm, usually about 7.5 cm.

Alberta

Hasse Lake individuals have the following characters: dorsal fin soft rays 7-12 (usually 9-11); anal fin with 1 short spine and 6-10 rays (usually 7-9); gillrakers on first arch 15-22 (usually 17-19); vertebrae 31-33. Maximum length observed in Hasse Lake 5.9 cm standard length.

Distribution

● Northern Hemisphere in coastal marine and fresh waters and inland to elevations usually not exceeding 100 m, primarily in Pacific and

Atlantic drainages of North America, Europe, and Asia; very rare in Arctic but present in coastal areas around Hudson and Ungava bays. In addition, the threespine stickleback has become established in the Great Lakes above Niagara Falls after first being reported in 1980.
■ Known in Alberta only from Hasse Lake where it was illegally introduced in the late 1970s. This is the only population known in the interior plains of North America.

Biology

Threespine sticklebacks occur in the ocean, lakes, and streams. They may be marine, anadromous, or fresh water. This species builds its nest on the substrate; its courtship and nesting behavior, ecology, and morphological divergence have been the subject of many studies.

In Hasse Lake they may have caused an observed decrease in the numbers of native brook stickleback. They probably compete for food with the introduced rainbow trout but they are in turn eaten by rainbow trout (Smith 1989).

Historical Note

C. Linnaeus first described the threespine stickleback in 1758 from Europe as *Gasterosteus aculeatus*. It was first collected in Alberta from Hasse Lake in 1980 (Nelson and Harris 1987). The population is obviously an introduction, probably made between 1975 and 1978. It is unfortunate that the origin of this population remains unknown because such knowledge would be valuable in studying morphological divergence in this species. Native species are frequently detrimentally effected by exotic species and continued education is required to guard against such illegal introductions.

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21 Sculpin Family—Cottidae

SCULPINS OCCUR IN the oceans and fresh waters throughout most of the Northern Hemisphere. In addition, four marine species occur in the Southern Hemisphere in the general Australian-New Zealand region. Most species are marine and their greatest diversity is along the North Pacific coastline. The large freshwater genus *Cottus* is found throughout much of the Northern Hemisphere. This family contains about 300 marine and freshwater species of which about 120 occur in North America. Many more occur in Eurasia, especially in Japan and Lake Baikal. Eight species regularly occur in fresh water in Canada with four in Alberta (seven in freshwater in British Columbia; and three in the Northwest Territories and Saskatchewan). There is, however, considerable taxonomic confusion in some of the sculpin species including one found in Alberta.

Most freshwater sculpins are small fish, seldom over 17 cm in length, but a few marine species reach lengths of over 70 cm. They are generally bottom-dwelling fish living in cool waters.

Compared to the other fishes in Alberta, sculpins have a relatively large and depressed head. On a world-wide basis, species of the family have 5-7 branchiostegal rays (usually 4 ceratohyal and 2 epihyal), 4-10 pyloric caeca, and two separate dorsal fins (the first weakly spinous, the second soft-rayed). The pelvic fin has a slender spiny splint bound by a membrane to the first soft-ray and not apparent without dissection or staining. The body is either naked or provided with prickles or a few scales. The swim bladder is usually absent in the adult.

Sculpins are usually placed in the order Scorpaeniformes (some authors include scorpaeniforms in the order Perciformes). Other families that are considered to be related at the ordinal level include the lump-

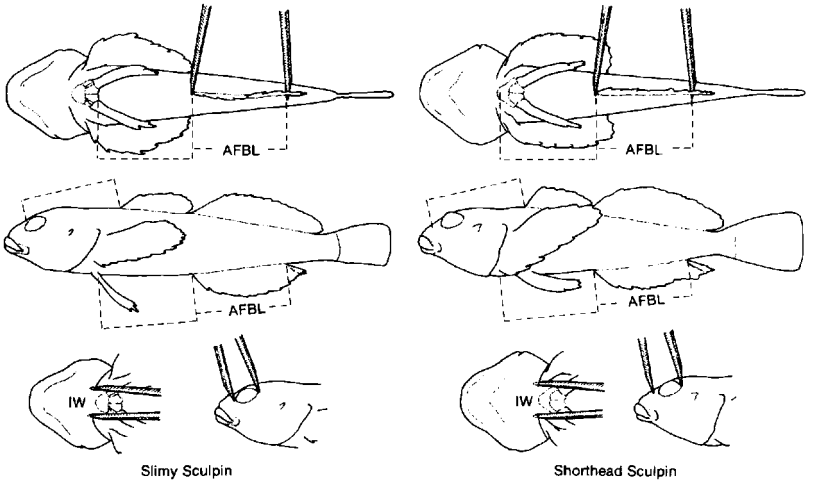


Fig. 21a Diagram showing the difference between the slimy sculpin (*Cottus cognatus*, from Athabasca River drainage) and shorthead sculpin (*Cottus confusus*, from Milk River). AFBL = anal fin base length; IW = isthmus width.
Slimy sculpin (left)-anal fin base length equal to or less than distance from anal fin origin to mid-point of base of pelvic fin and about equal to distance from origin of spiny dorsal fin to anterior margin of eye; width of isthmus about equal to eye length.
Shorthead sculpin (right)-anal fin base length usually equal to distance from anal fin origin to in front of pelvic fins and usually greater than distance from origin of spiny dorsal fin to anterior margin of eye; width of isthmus greater than eye length. Note: identification of these specimens in Alberta as shorthead sculpin is uncertain.
Drawing by Annemarie Mobach based on information provided by W.E. Roberts.

suckers, snailfishes, poachers, greenlings, and scorpionfishes (or rockfishes), all of which are common off British Columbia in the Pacific Ocean.

Key to the 4 Species

Use the following key and Fig. 21a to identify a species in the sculpin family. For an explanation of how to use the key, see Section 7.2. See Appendix I for information on two species adjacent to Alberta in British Columbia and not in this key: the prickly sculpin, *Cottus asper*, in Peace and Columbia river drainages; and the torrent sculpin, *Cottus rhotheus*, in the Columbia River drainage. One specimen of the prickly sculpin has been obtained in the Peace River in Alberta and since there is no barrier to downstream movement more specimens are expected to be found; this species, like the spoonhead sculpin, *Cottus ricei*, has one

pore on the midline at the tip of chin. See text on the shorthead sculpin, *Cottus confusus*, for comments on the mottled sculpin, *Cottus bairdi*; we very provisionally use the former name for specimens from southern Alberta identified as the mottled sculpin in Paetz and Nelson (1970).

1A Gill membranes not attached to isthmus and extending slightly forward from their origin, gill openings wide (condition similar to that of burbot shown in Fig. 7d, inset "c"); dorsal fins separated by a distinct gap..... .....**Deepwater sculpin—*Myoxocephalus thompsoni*.** SEE SECTION 21.4.

1B Gill membranes attached to isthmus, gill openings narrow in ventral view (condition similar to that of suckers shown in Fig. 7d, inset "a"); two distinct dorsal fins but first touching the second.....GO TO 2A AND 2B.

(FROM 1B)

2A Median pore at tip of chin (other pores exist posteriorly along the margin of the lower jaw); upper spine on preopercle very long and curved upward and inward; lateral line extending onto caudal peduncle (in specimens over 3 1/2 cm); head wide and flat; distinct prickles usually covering most of body except in very larg individuals.....**Spoonhead sculpin—*Cottus ricei*.** SEE SECTION 21.3.

2B Two pores bordering midline at tip of chin; upper spine on opercle not long and only slightly curved; lateral line not extending onto caudal peduncle; head rounded in profile; prickles small and not covering most of body.....GO TO 3A AND 3B.

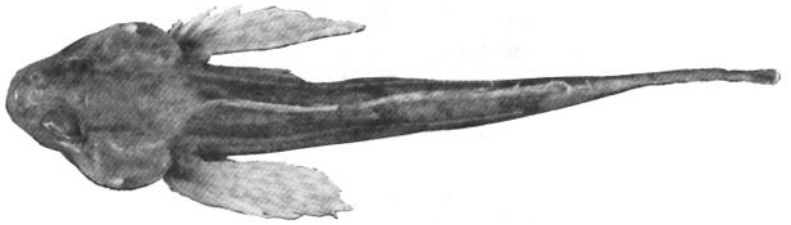
(FROM 2B)

3A No teeth on palatine bones; anal fin with 10 to 13 soft rays. See also Fig. 21a.....**Slimy sculpin—*Cottus cognatus*.** SEE SECTION 21.1.

3B Teeth on palatine bones; anal fin with 11 to 15 (usually 12 or 13) soft rays.....**Shorthead sculpin—*Cottus confusus*.** SEE SECTION 21.2.

21.1 Slimy Sculpin *Cottus cognatus* Richardson

[*Cottus*: an old name for the common European fresh-water sculpin; *cognatus*: related, to the European species *Cottus gobio*]



Slimy sculpin adult, 5.8 cm standard length, from a tributary of the Cutbank River.

Description

Color: Dark brown or grayish-yellow mottling dorsally and laterally. Two or three darkish bands under the second dorsal fin, dark brown bars on pectoral and caudal fins. Peritoneum silvery with few black spots. Breeding males with spinous dorsal fin black and lined with orange.

Body: Rounded in section. Head subconical and slightly depressed between the eyes; distance between the eyes about 1/2 to 1 times eye length; eyes large; mouth moderate in size (tip of maxilla extending past anterior margin of eye), terminal, and horizontal to slightly oblique. Continuous groove separating upper lip from snout. Posterior nostrils not tubular. Teeth on upper and lower jaws and vomer but very seldom on palatines. About 10 pores on each side along lower surface of lower jaw; two pores on tip of chin, one on either side of midline. Short preopercular spine covered with skin but visible without dissection (other spines hidden from view). Gill membranes joined to a moderately wide isthmus, about 1/4 width of head. Pectoral fin base strongly oblique (sloping backwards at top). Pelvic fin insertion under anterior third of pectoral fin. Prickles indistinct and found only behind the pectoral fin base. Lateral line incomplete, ending below or before middle of second dorsal fin. Caudal fin

Map 21.1 Distribution of slimy sculpin in Alberta.

slightly rounded (convex). Lateral-line pores 12-25. First dorsal fin with 7-10 spines and second dorsal fin with 15-19 soft rays (usually 16 or 17). Anal fin rays 10-13. Pectoral fin rays 12-15 (usually 13 or 14). Pelvic fin with 1 weak spine and 3 or 4 soft rays. The slimy sculpin shows much geographic variation in number of pelvic fin rays and presence or absence of branching in the last anal ray; generally, 4 pelvic rays and branched last anal ray predominate in the northwestern part of its range while to the south and east (including most of Alberta) 3 pelvic rays and an unbranched last anal ray are most common. Some British Columbia populations are intermediate in the two characters (see McPhail and Lindsey 1970, for additional details).

Size: Maximum length 12.8 cm (Mohr 1984).

Alberta

Vertebral number from 48 specimens obtained from Peace, Athabasca, and Beaver river drainages: 31 in 1 specimen, 32 in 13, 33 in 22, 34 in 10, and 35 in 2.

One specimen of *C. cognatus* donated by D.W. Mayhood has the branchiostegal membranes connected to each other and free of the isthmus (collected from Pinto Creek in the Wapiti River drainage near Grande Prairie; UAMZ 4628). Abnormalities sometimes occur in fish species, but when this occurs in a character used in a "key" it can be particularly confusing.

Maximum length noted from Alberta is 9 cm fork or total length from Cold and Christina lakes.

Distribution

● Eastern Siberia and Alaska to New Brunswick and Washington to Virginia.

■ Known in Alberta from Petitot, Hay, Slave, Peace, Athabasca, and Beaver river drainages (see Map 21.1). The fish reported from Sylvan Lake, in an early report by D.S. Rawson, and other reports of the slimy sculpin from other parts of the Red Deer River drainage are probably in error. Specimens from the Milk River reported as *C. cognatus* by Wells (1977) are probably *C. confusus* (Roberts 1988a).

Biology

Slimy sculpins have an unusually large range and occur in lakes and cool rocky streams. Like other members of the genus *Cottus*, they usually

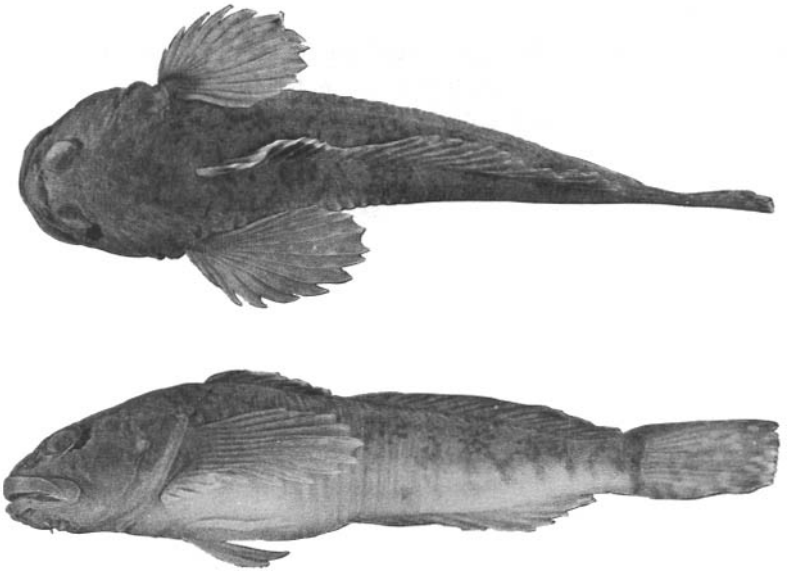
occur between and under rocks. They feed on aquatic insects, crustaceans, small fish, and plant material. Spawning probably occurs in May and early June. The male prepares a nest site under an object such as a rock where the female deposits the adhesive eggs. The male guards the eggs and newly hatched young sculpins. The slimy sculpin may live as long as 7 years.

Historical Note

Sir J. Richardson first described the slimy sculpin in 1836 from Great Bear Lake as *Cottus cognatus*. It was first noted in Alberta by Kendall (1924) from Poplar Point, Lake Athabasca.

21.2 Shorthead Sculpin *Cottus confusus* Bailey and Bond

[*Cottus*: an old name for the common European fresh-water sculpin; *confusus*: Latin for clouded, refers to the irregular and indistinct body pigmentation]



Shorthead sculpin adult, 7.0 cm standard length, from North Fork Milk River west of Del Bonita.

Description

The shorthead sculpin is similar to the slimy sculpin. The following characters distinguish it from other western Canadian sculpins: short papillae on the head; teeth on the palatine bones (usually requires microscopic examination, teeth may be weakly developed and very hard to see); head length relatively short, anal fin base relatively long, and isthmus width about equal to length of eye (see Fig. 21a); few or no prickles on body. Dorsal fin spines 7-9; dorsal fin soft rays 11-15; anal fin rays 11-15 (usually 12 or 13); pectoral fin rays usually 13 or 14; lateral line pores usually 20-30 (see Roberts 1988a for specific Alberta counts).

Maximum length in Alberta 10.8 cm total length (Roberts 1988b).

Map 21.2 Distribution of shorthead sculpin in Alberta.

Distribution

● Southern British Columbia and southern Alberta to Oregon; primarily occurring in Columbia River drainage. In British Columbia it is known from the Flathead River, very near the Alberta border, and in the Kettle, Columbia, and Slocan rivers, where it is broadly sympatric with *Cottus asper*, *C. bairdi* (= *C. hubbsi*), and *C. rhotheus* (Peden et al. 1989).

■ Known in Alberta only from the St. Mary (a tributary to the upper Oldman River), and Milk river drainages (see Map 21.2).

Biology

Roberts (1988b) reports males in mid-May guarding eggs that were deposited under rocks. Most females contained 100-250 eggs, but one female of 8.1 cm length had 354 eggs. Like other members of the genus, feeding is primarily on aquatic insects. The shorthead sculpin and some other species in the St. Mary River drainage may have gained access to the Milk River by irrigation canals in Montana.

Historical Note

R.M. Bailey and C.E. Bond first described the shorthead sculpin in 1963 as *Cottus confusus*. The specimen designated as the holotype is from the Salmon River in the Snake-Columbia River drainage, Idaho. This species was first recognized in Alberta as the mottled sculpin, *Cottus bairdi* Girard (Henderson and Peter 1969; Willock 1969a, b; Paetz and Nelson 1970). Its identification as *Cottus confusus* is based on the taxonomic studies of Roberts (1988a). However, Peden et al. (1989) found two distinct forms of the nominal *C. confusus* in British Columbia, one from the Flathead River (similar to Alberta specimens) and the other from the Columbia and Kettle rivers. The form from the Columbia and Kettle rivers most closely resembles the shorthead sculpin described by Bailey and Bond. More taxonomic work is required to resolve the question as to whether the Flathead-St. Mary-Milk River form in southern Alberta is: i) of the same species as a variable and widespread *C. bairdi* as originally thought, ii) of the same species as the Columbia River drainage *C. confusus*, or iii) representative of a third and undescribed species (and if so, is it phylogenetically closest to *C. bairdi* or to *C. confusus*).

Bajkov (1927) identified a sculpin with palatine teeth from the Athabasca and Maligne rivers near Jasper as *Cottus punctulatus* (Gill),

the speckled Rocky Mountain bullhead which is considered to be a subspecies of *C. bairdi*. The identity of this specimen is uncertain; it may be an unusual specimen of *C. cognatus* with palatine teeth, a species that is also in adjacent areas on the west side of the Rocky Mountains in British Columbia.

21.3 Spoonhead Sculpin *Cottus ricei* (Nelson)

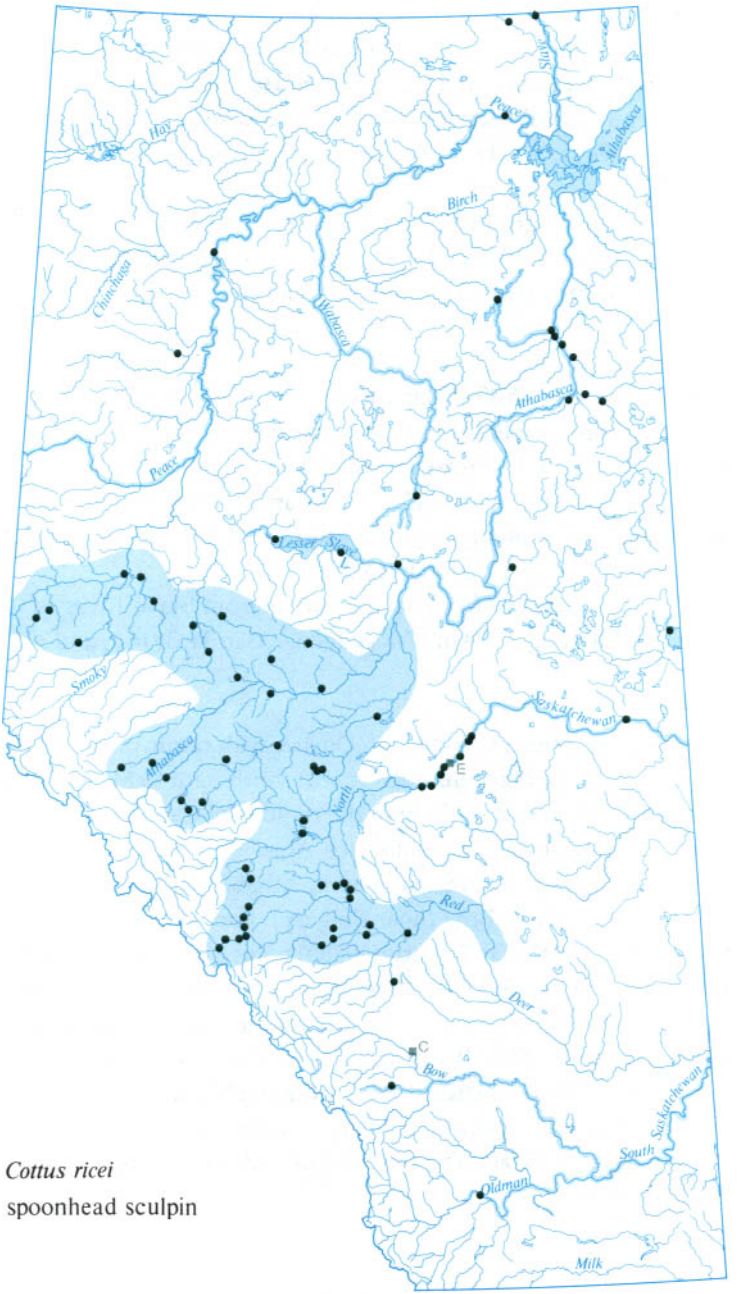
[*Cottus*: an old name for the common European fresh-water sculpin; *ricei*: after its discoverer Mr. F.L. Rice]

Spoonhead sculpin adult, about 8.0 cm standard length, from Tay River of the Clearwater-North Saskatchewan River drainage, 9 March 1979. Photo courtesy of W.E. Roberts.

Description

Color: Light brown or greenish-brown dorsally with dark markings. Darkish bands on pectoral and caudal fins. Peritoneum silvery with few or no black spots.

Body: Rounded in section. Head very depressed, broad and flat; distance between the eyes 1 1/4 times eye length, eyes moderate in size; mouth small (tip of maxilla usually not quite extending to anterior margin of eye), terminal, and slightly oblique. Continuous groove separating upper lip from snout. Posterior nostrils semitubular. Teeth on upper and lower jaws and on vomer but not on palatines. About 10 pores on each side along underside of lower jaw plus a median pore at tip of chin (this pore may appear split but there are not 2 separated openings). Preopercular spines 2-4, the uppermost elongate and curved inward and upward, the others concealed by skin. Gill membranes joined to a broad isthmus, about 1/3 or more width of head. Pectoral fin base strongly oblique (sloping backwards at top). Pelvic fin insertion under front third of pectoral fin. Prickles usually over entire body (appearing as small dense white bumps or as spines), sometimes nearly absent. Lateral line slightly decurved



Map 21.3 Distribution of spoonhead sculpin in Alberta.

under the first dorsal fin and usually complete; does not bend down to midline on the caudal peduncle, unlike in the prickly sculpin (Appendix I). Caudal fin slightly rounded (convex). Lateral-line pores 33-36. First dorsal fin with 6-10 spines and second dorsal fin with 16-19 soft rays. Anal fin rays 11-16 (usually 12 or 13). Pectoral fin rays 14-16.

Size: Maximum length 13.5 cm total length from the Clearwater River, Alberta (Roberts 1988a) (UAMZ 6818, a skeletal preparation). The previous record was 13.4 cm from Quebec.

Alberta

Fin ray counts from 85 specimens from Slave River to Oldman river drainages are as follows. Dorsal spines: 6 in 3 specimens, 7 in 27, 8 in 54, and 9 in 1. Dorsal soft rays (last two elements counted as one): 16 in 12 specimens, 17 in 31, 18 in 39, and 19 in 3. Anal soft rays (last two elements counted as one): 11 in 2 specimens, 12 in 16, 13 in 50, 14 in 15, and 15 in 2.

Vertebral number from 54 specimens from Slave River to Oldman river drainages : 34 in 17 specimens, 35 in 34, 36 in 2, and 37 in 1.

Distribution

● Northeastern British Columbia to Quebec with northward extensions to the mouth of the Mackenzie River and southward to Michigan; this species is found almost entirely in the regions of Canada which were glaciated during the Wisconsinan Ice Age.

■ Known in Alberta from Slave, Peace, Athabasca, North Saskatchewan, upper Red Deer, Bow (near Calgary), and upper Oldman river drainages (see Map 21.3). Roberts (1988b) notes a decline in abundance of this species in the Red Deer River downstream of the Dickson Dam (forming Gleniffer Lake) following construction. One small specimen is known from the Milk River drainage (UAMZ 454 collected by R.B. Miller and J.C. Ward, 8 August 1950, from the North Fork Milk River, near Del Bonita); it may have come from the Oldman River drainage through irrigation canals. The spoonhead sculpin is primarily a stream species in Alberta.

Biology

Spoonhead sculpins occur in rivers (often muddy ones) and in lakes (in shallow and deep water); they are most abundant in streams in the foothills and adjacent plains. Near Fort Smith they occur in clear rivers;

we have found them in the "salty" Salt River and Brine Creek (Nelson and Paetz 1972). They spawn in the spring, usually in April and May.

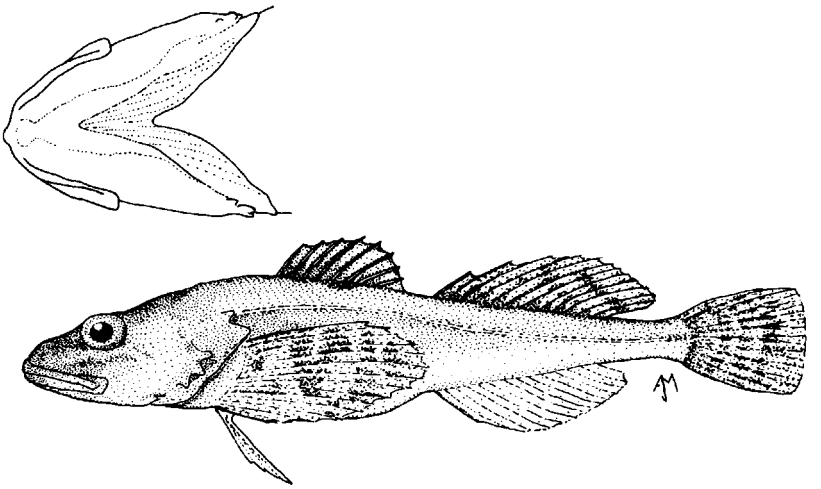
Aspects of the life history of this species are described by Roberts (1988a, b). Males defend suitable spawning sites, usually a rock; courted females may attach 280-1200 adhesive eggs to the underside of the rock. The male guards and fans the eggs for 2 to 3 weeks until hatching occurs. The young are active over the substrate and older individuals live under rocks and come out at night to feed (W.E. Roberts, personal communication).

Historical Note

E.W. Nelson first described the spoonhead sculpin in 1876 from Lake Michigan at Evanston as *Cottopsis ricei*. It was first noted in Alberta by Eigenmann and Eigenmann (1892) and Eigenmann (1895) at Calgary (Bow River) as a new species, *Cottus onychus*.

21.4 Deepwater Sculpin *Myoxocephalus thompsoni* (Girard)

[*Myoxo cephalus*: Greek for "head like a dormouse"; *thompsoni*: named for Rev. Zadock Thompson, author of the History of Vermont]



Deepwater sculpin; insert shows that the margins of gill membranes are not attached to the isthmus, 12.4 cm standard length. Specimen from Lake Michigan.

Description

This species can be distinguished from other freshwater sculpins by the following characteristics: two dorsal fins separated from each other by a distinct gap, the first dorsal fin usually with 7-9 spines and the second usually with 12-15 soft rays; total of 4 preopercular spines, the upper 2 large, slender, sharing a common base, and pointing upward and posteriorly; lateral line usually extending past end of second dorsal fin; tubercles present above lateral line, usually fewer than 30; vertebrae usually 37-40. Alberta specimens are somewhat unusual in having large and numerous papillae behind the eyes (McAllister and Ward 1972).

Maximum length about 24 cm, usually less than 9 cm.

Distribution

● The deepwater sculpin is a glacial relict found in scattered localities from the Great Bear-Great Slave lakes area, Waterton Lake, and northern Saskatchewan through to southwestern Quebec including the Great Lakes region. A somewhat similar form in Europe probably originated independently from a euryhaline ancestor.

■ Known in Alberta only from upper Waterton Lake in the southwestern part of the province. It would not be surprising to find it in other lakes such as Cold Lake.

Biology

This species occurs in cold and deep lakes. Very little is known of its biology (Parker 1988).

It is quite similar to the fourhorn sculpin, *Myoxocephalus quadricornis*, and the relationship of the two is uncertain. However, the latter is usually marine and has four distinct bony knobs on top of the head. Many authors have considered the two forms to be subspecies of the same species; however, recent studies show that all specimens can be distinguished, and separate species status is thus appropriate. It is quite possible that some freshwater populations have been independently derived from the marine species.

Historical Note

C.F. Girard first described the deepwater sculpin in 1851 from Lake Ontario near Oswego, as *Triglopsis thompsoni*. It was first collected in Alberta when two small specimens were caught in Upper Waterton Lake in 1966 by K. Goble (McAllister and Ward 1972).

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22 Perch Family—Percidae

MEMBERS OF THE perch family occur in fresh water throughout most of the Northern Hemisphere. The family contains about 155 species, and most of them are in the eastern half of the United States. They are not native west of the Rocky Mountains in North America and only about 14 species are native to Eurasia. Small bottom-dwelling forms, called darters, make up the vast majority of the species in the family. Fourteen species of the perch family occur in Canada with five in Alberta (one in British Columbia plus the yellow perch which is there as a result of an introduction into Washington State; two in the Northwest Territories; and seven in Saskatchewan). Information on the yellow perch and on other members of the family is given in Craig (1987). Two other books, Page (1983) and Kuehne and Barbour (1983), describe the many species of darters.

Members of the perch family have two dorsal fins, the first contains spines and is separate or narrowly joined with the soft dorsal fin. In addition, they have 5-8 branchiostegal rays (usually 2 epihyal and 5 ceratohyal), 32-50 vertebrae, pelvic fins each with 1 spine and 5 branched rays, an anal fin with 1 or 2 spines, and 2 nostrils on either side of the head.

Perch are placed in the largest and most diversified of all vertebrate orders, the Perciformes, which comprises 150 families of freshwater and marine fish. They are close relatives of the sunfishes (Centrarchidae).

Key to the 5 Species

Use the following key and Fig. 22a to identify a species in the Perch family. For an explanation of how to use the key, see Section 7.2.

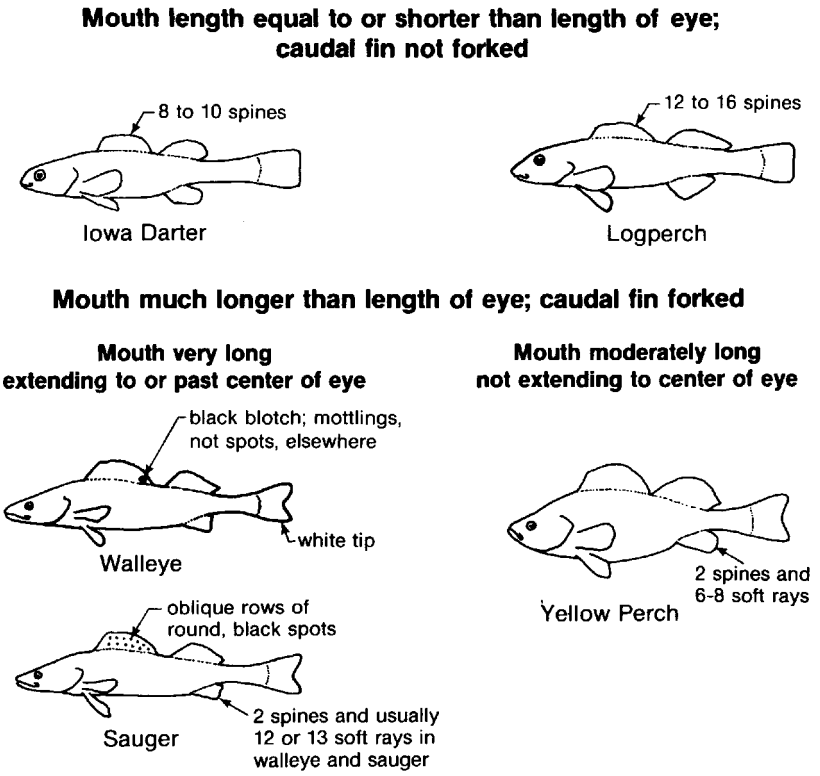

Mouth length equal to or shorter than length of eye; caudal fin not forked
8 to 10 spines
Iowa Darter
12 to 16 spines
Logperch
Mouth much longer than length of eye; caudal fin forked
Mouth very long extending to or past center of eye
Mouth moderately long not extending to center of eye
black blotch; mottlings, not spots, elsewhere
white tip
Walleye
2 spines and 6-8 soft rays
Yellow Perch
oblique rows of round, black spots
2 spines and usually 12 or 13 soft rays in walleye and sauger
Sauger
Pictorial Guide to Percids of Alberta

Fig. 22a Outline drawings to supplement the Key to the 5 percids of Alberta.

See Appendix I for information on the johnny darter, known from Saskatchewan, and on smallmouth bass, which have been introduced into Alberta.

1A Posterior end of upper jaw usually not extending past anterior margin of eye; lower border of preopercle smooth; premaxillae non-protractile; maximum length under 12 cm..... .....GO TO 2A AND 2B.

1B Posterior end of upper jaw extending well past anterior margin of eye; lower border of preopercle with strongly serrated (rough) edge; premaxillae protractile; maximum length over 12 cm.. .....GO TO 3A AND 3B.

(FROM 1A)

2A First dorsal fin with 8 to 10 spines; snout blunt; anal fin size smaller than that of second dorsal fin ..... **Iowa darter—*Etheostoma exile*.**
SEE SECTION 22.1.

2B First dorsal fin with 12 to 16 spines; snout forms a conical protuberance; anal fin size about equal to that of second dorsal fin ..... **Logperch—*Percina caprodes*.**
SEE SECTION 22.2.

(FROM 1B)

3A Teeth small and relatively uniform in size; pelvic fins so close together that the inner edges of their bases almost touch; anal fin with 6 to 8 soft rays (and 2 spines)..... **Yellow perch—*Perca flavescens*.**
SEE SECTION 22.3.

3B Several large teeth present, interspersed with relatively small teeth; distance between pelvic fins about equal to the width of the base of either fin; anal fin with 11 to 14 soft rays (and 2 spines) ..... GO TO 4A AND 4B.

(FROM 3B)

4A First dorsal fin with oblique rows of round, black spots (not evident in young under 15 cm); first dorsal fin without prominent black blotch on posterior end; pyloric caeca 3 to 9 (useful in fish as short as 3 cm), the longest caecum much shorter than length of stomach; lower lobe of caudal fin without white tip..... **Sauger—*Stizostedion canadense*.**
SEE SECTION 22.4.

4B First dorsal fin with only obscure mottlings; first dorsal fin with prominent black blotch on posterior end (not always prominent on young under 15 cm); pyloric caeca 3, each about as long as stomach; lower lobe of caudal fin with white tip..... **Walleye—*Stizostedion vitreum vitreum*.**
SEE SECTION 22.5.

22.1 Iowa Darter *Etheostoma exile* (Girard)

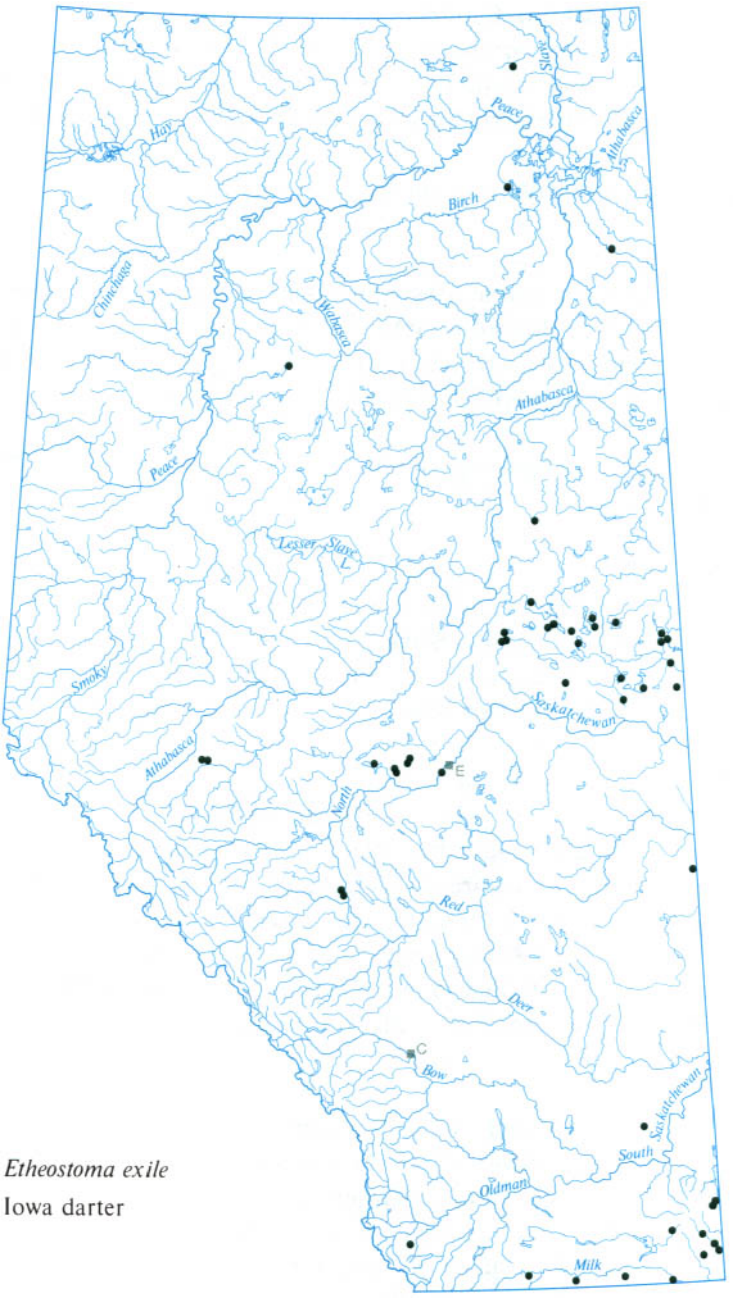
[*Etheo stoma*: etymology uncertain, stated by author of type species to mean "various mouths"; *exile*: slim]

Iowa darter adult male 5.2 cm fork length from Ghostpine Creek June 1991. Photo courtesy of W.E. Roberts.

Description

Color: Pale olivaceous dorsally, about 8 dark saddle bands laterally. Breeding males vividly colored with 9-12 dark blue blotches on side alternating with brick-red blotches. Lower sides orange-yellow. Spinous dorsal fin with blue and orange markings. Peritoneum silvery with numerous black spots.

Body: Moderately laterally compressed and slender. Head subconical and flattened dorsally; distance between the eyes about equal to eye length; eyes large; mouth moderate in size (tip of maxilla extending past anterior margin of eye), very slightly subterminal, and horizontal to slightly oblique; upper lip not separated from snout by a continuous groove (i.e., frenum present and premaxillae not protractile); front margin of snout rounded. Cheeks fully scaled. Teeth very small, in bands confined to upper and lower jaws. Gill membranes extending forward and narrowly joined to each other (nearly separate). Pectoral fin base strongly oblique (sloping forwards at top) to almost vertical, mostly on lower half of body. Distance between inner rays of pelvic fins less than width of base of either fin. Lateral line incomplete (fewer than 35 pores and ending before or under the



Map 22.1 Distribution of Iowa darter in Alberta.

second dorsal fin). Caudal fin slightly rounded (convex). Lateral-line scales (along normal position) 45-65. First dorsal fin usually with 8-10 spines and second dorsal fin with 9-12 soft rays; anal fin with 2 spines (the first larger than the second) and 7-9 soft rays. Vertebrae 36-39.

Size: Maximum length 6.8 cm standard length.

Alberta

Vertebral number from 103 specimens from Pine Lake (Wood Buffalo National Park) to southern Alberta: 36 in 1 specimen, 37 in 17, 38 in 39, 39 in 26, 40 in 17, and 41 in 3. In a few specimens from Wabamun Lake there were 7-10 gillrakers in the first arch and 3 or 4 pyloric caeca.

Maximum length noted for Alberta is 6.1 cm fork length from Cold Lake.

Distribution

● Alberta to Quebec and Colorado to Ohio.

■ Known in Alberta from Slave (Pine Lake only), Peace, Athabasca, Beaver, North Saskatchewan, upper Battle, upper Red Deer, Bow, and Milk river drainages (see Map 22.1).

Biology

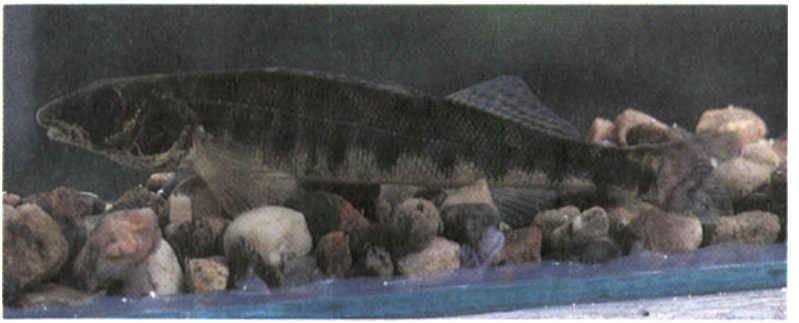
The Iowa darter occurs in lakes and clear slow streams, particularly in shallow water around aquatic vegetation. They spend most of their time on the bottom and feed primarily on aquatic insects. Spawning occurs in the spring and early summer; eggs are attached to stones, often in crevices. Smith (1979) has found an alarm substance in the skin of this species analogous to that found in cyprinids and their relatives (see Chapter 12 for a comment on alarm substance).

Historical Note

C.F. Girard first described the Iowa darter in 1859 from a tributary of the upper Missouri River as *Boleichthys exilis*. It was first noted in Alberta by Miller and Macdonald (1950) from Battle Creek, Cypress Hills, and Beauvais Lake as *Poecilichthys exilis* from specimens collected August 1947 and July 1949, respectively, and from a collection made in Muriel Lake by R.B. Miller in July 1948.

22.2 Logperch *Percina caprodes* (Rafinesque)

[*Percina:* a diminutive of *Perca; caprodes:* resemblance to a pig, in reference to its snout]



Logperch adult male, 8.4 cm fork length, from the Marie Lake. Photo courtesy of W.E. Roberts.

Description

Logperch differ from other percids in the following characters: body with 14-20 dark, narrow bars; head conical and pointed with a small mouth (hind tip of maxilla not extending past anterior margin of eye); upper lip not separated from snout by a continuous groove (i.e., frenum present); pelvic fin bases widely separated; first dorsal fin with 12-16 spines (usually 14 or 15), second dorsal fin with 14-17 soft rays, and anal fin usually with 2 spines and 9-11 soft rays (the anal fin is about as large as the second dorsal fin); lateral line with 71-95 scales; vertebrae 41-45.

Maximum length 15 cm, usually less than 11 cm.

Alberta

Vertebral number in 22 specimens from Marie Lake (UAMZ 5373): 41 in 5 specimens and 42 in 17.

Maximum known length in Alberta 8.1 cm standard length or 9.5 cm fork length.

Distribution

● Occurs from Beaver River drainage of Alberta to southern Quebec and south from Texas to Georgia. It has the largest range of all darters.

■ Known in Alberta only from Cold (UAMZ 3148) and Marie (UAMZ 4317, 5373) lakes in the Beaver River drainage.

Biology

Logperch inhabit lakes and rivers. In many lakes, other than during the spawning period, they occur at depths greater than a meter, thereby going undetected in shoreline collections such as those made with a seine net or a dip net. They feed primarily on crustaceans and aquatic insect larvae. Spawning occurs in the late spring and early summer. Fertilized eggs may be buried in the substrate during the spawning act.

Historical Note

C.S. Rafinesque first described the logperch in 1818 from the Ohio River as *Sciaena caprodes*. It was first collected in Alberta by W.E. Roberts on 4 August 1971 from the mouth of the Medley River, Cold Lake (Roberts 1973).

22.3 Yellow Perch *Perca flavescens* (Mitchill)

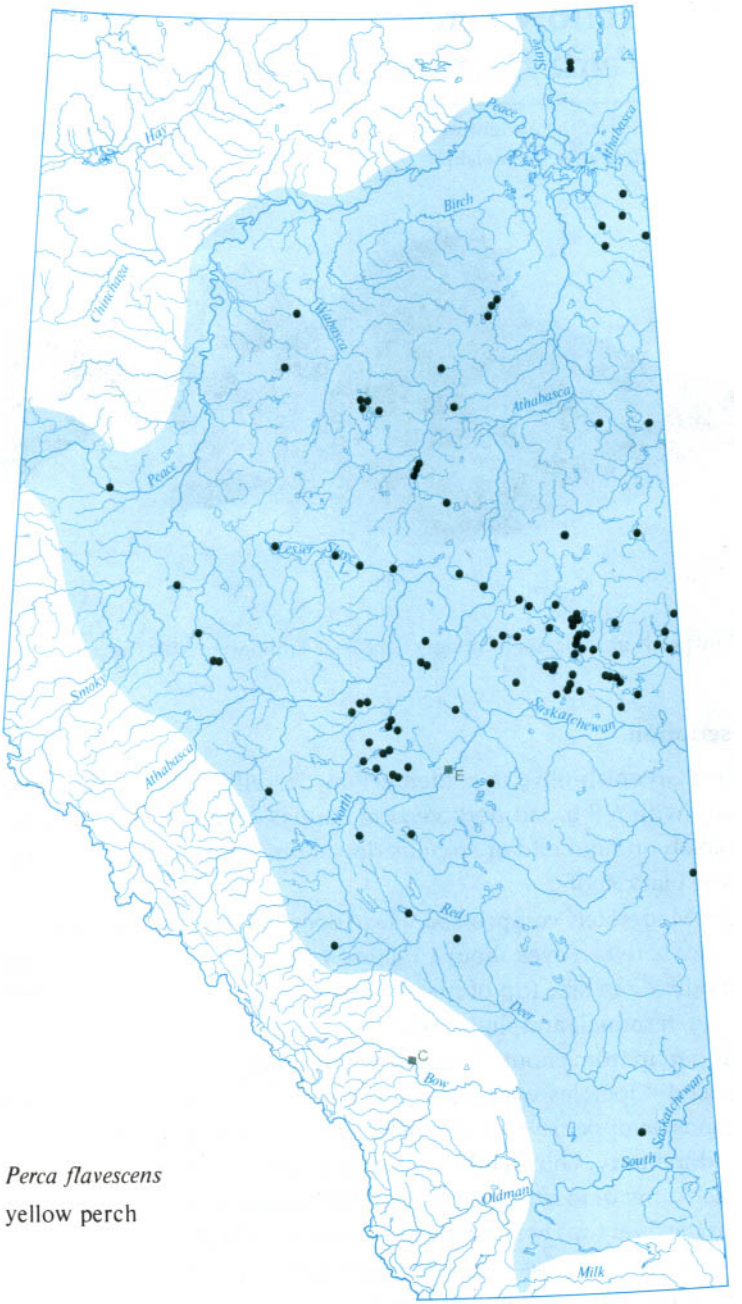
[*Perca:* the ancient name for the European perch, meaning dusky; *flavescens:* yellowish]

Yellow perch from Spring (Cottage) Lake near Edmonton. M.J. Paetz

Description

Color: Greenish-olive or golden yellow dorsally, golden yellow laterally with 6-9 broad dark vertical bands, white ventrally. Darkish blotch on hind end of spinous dorsal fin. Peritoneum silvery with few black spots.

Body: Moderately compressed. Head deep and rounded dorsally; distance between eyes about 1 1/4 times eye length; eyes large; mouth moderate in size (tip of maxilla extending past anterior margin of eye), terminal, and slightly oblique. Continuous groove separating upper lip from snout; front margin of snout rounded. Cheeks fully scaled. Opercles with a sharp spine. Teeth small (no canines), in bands on upper jaw, vomer, palatines, and lower jaw. Pseudobranch rudimentary. Gill membranes extending forward and not joined to each other or to isthmus. Pectoral fin base strongly oblique (sloping forwards at top) to almost vertical; on lower half of body. Distance between inner rays of pelvic fins less than width of base of either fin. Ctenoid scales covering body. Lateral line arched upward and on dorsal half of body, curving down to midline on the caudal peduncle (generally following the dorsal contour), usually ending at base



Map 22.3 Distribution of yellow perch in Alberta.

of caudal fin. Caudal fin moderately forked. Lateral-line scales 52-60. First dorsal fin with 12-15 spines, second dorsal fin with 1-3 spines and 12-15 soft rays; anal fin with 2 strong spines and 6-8 soft rays. Larvae have about 16-21 myomeres between the anus and caudal fin.

The sex of adult perch can be determined from an examination of the urogenital opening (behind the anus). Packham (1988) found that in females the opening tends to be round with surrounding tissue forming a white, doughnut-like ring; males have a slightly oval opening that lacks raised white tissue.

Size: Maximum length probably 38.7 cm (from Alberta, see below). Most perch are much smaller at maximum size.

Alberta

Vertebral number from 168 specimens, primarily from central latitudes of Alberta: 39 in 23 specimens, 40 in 118, and 41 in 27. In a few specimens from Lac Ste. Anne there were 17-22 gillrakers and 3 pyloric caeca.

Maximum length noted for Alberta is 38.7 cm (1.35 kg) from Moose Lake (a fish angled in 1983 by the late Ron Hancheruk and listed in Alberta Fish and Game Association 1986).

Distribution

● The yellow perch occurs from Alberta to Nova Scotia and northern Missouri to western Pennsylvania to South Carolina. It has been introduced outside this range (e.g., Okanagan and Kootenay drainages in British Columbia). A close relative, *Perca fluviatilus* Linnaeus, occurs in Europe and Asia.

■ Known in Alberta from Peace, Slave, Athabasca, Beaver, North Saskatchewan, upper Battle, Red Deer, Bow, and Oldman river drainages (see Map 22.3).

Biology

The yellow perch is common in lakes, ponds, and large slow-moving streams. They usually occur in loose schools. Nursall and Pinsent (1969) noted young perch to swim in schools with spottail shiners of similar size in Beaver Lake. Older perch, as well as other predators such as northern pike and walleye, swam below these schools, and the shiners were 10 times more likely to be taken by the fish predators than were the small perch. In general, perch feed predominately on plankton during their first year and later on aquatic insects, crustaceans, snails, and,

to a limited extent, on small fish. Sexual maturity is usually reached in the 3rd year with a life span seldom exceeding 7 years. They spawn in the spring, usually later than walleye. Eggs from an individual female are laid in a long ribbon-like gelatinous band that may be up to 2 m in length; the apparent absence of predation on these seemingly vulnerable egg masses suggests that they contain some unpalatable substance (Newsome and Tompkins 1985). The role of perch as a forage fish for larger game species is very important.

Larvae of the large tapeworm *Ligula intestinalis* often occur in the body cavity of perch. They are also susceptible to a trematode larvae of the genus *Neascus*, which cause black-spotted cysts in the skin; *Tetracotyle*, another trematode larvae which resemble tiny sand grains in the flesh; and the larvae of *Triaenophorus nodulosus*, which produce cysts in the liver. The larva of freshwater clams, termed glochidia, which must attach to a fish to complete its life cycle, frequently use perch. The larva may attach to most external body surfaces, preferring the pectoral and pelvic fins and the gills (see Clifford 1991, p.111, for a picture); infestations are higher from January to May (Jansen 1991; Jansen and Hanson 1991).

Studies on Alberta perch include Jacobson (1989), Jansen and Mackay (1991, 1992), Langer (1974), Mance (1987), Norris (1984), Nursall (1973), Packham (1988), and Tanasichuk (1978). In addition, ongoing studies on their biology are being conducted by Dr. W.C. Mackay at the University of Alberta. Craig (1987) reviews the literature of this species.

Angling

Perch are a popular sport fish in some areas at all seasons of the year but they are of limited commercial value in Alberta. They are probably our most common game fish in terms of numbers of fish caught and total angling time spent. The ease with which they are caught as well as their general abundance and excellent table qualities may account for this. Most perch fishing takes the form of ice fishing and still-fishing from small boats using casting or spinning tackle and small baited hooks. Earthworms, leeches, and maggots are most commonly used as baits. Perch are slowly gaining some recognition by fly fishermen. An assortment of wet flies are effective in taking perch.

Historical Note

S.L. Mitchill provided the first acceptable description of the yellow perch in 1814 from near New York City as *Morone flavescens*. Some

ichthyologists believe that the yellow perch in North America is of the same species as the European yellow perch, and some of these workers have proposed the subspecies designation *Perca fluviatilus flavescens* for the American yellow perch. It was first noted in Alberta by Whitehouse (1919) from Pine and Sylvan lakes near Red Deer.

22.4 Sauger *Stizostedion canadense* (Smith)

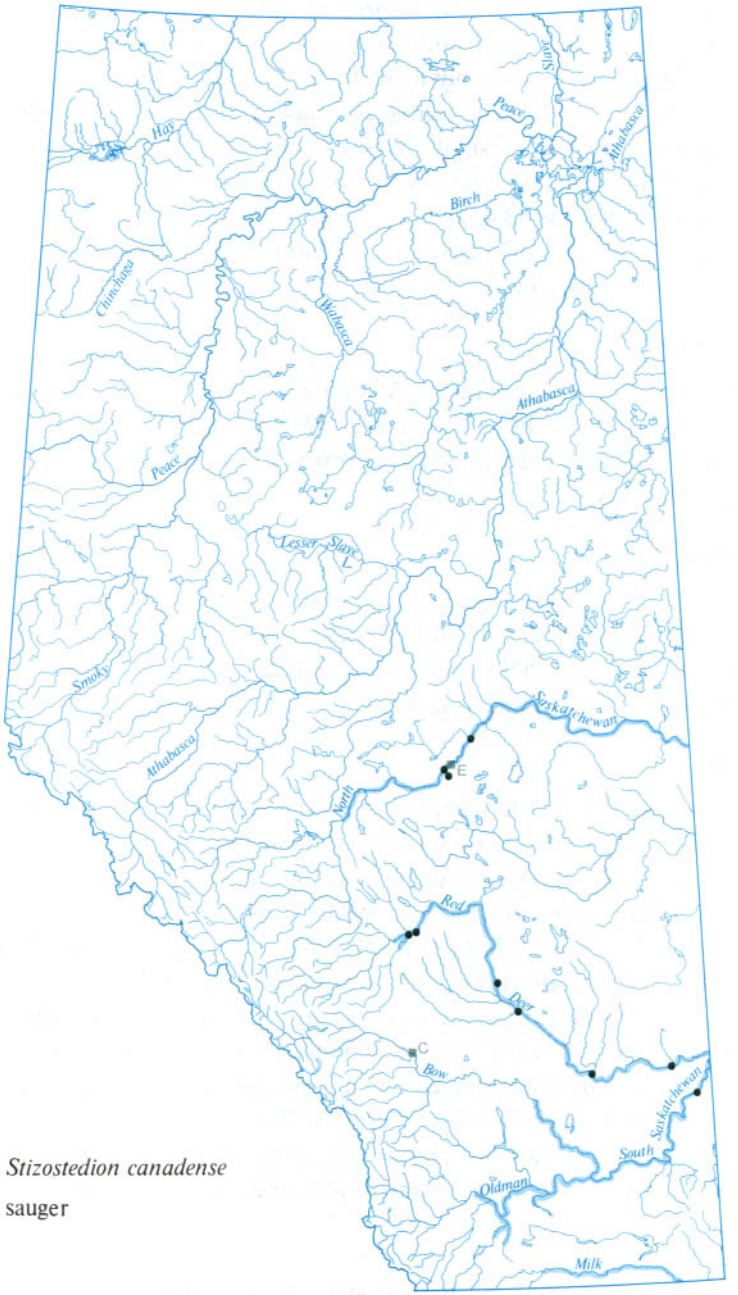
[*Stizo stedion:* to prick, a little breast (sharp pointed throat); *canadense:* of Canada]

Sauger from North Saskatchewan River. Photo courtesy of M. Robertson.

Description

Color: Golden olive dorsally, somewhat silver-yellow laterally, white ventrally. Usually 3 or 4 dusky oblique bars on body, 2 or 3 oblique rows of dusky half-moon spots on spinous dorsal fin (except in very young). Black spot at base of pectoral fin, usually no white tinge on anterior tip of anal fin or on lower lobe of caudal fin. Paired fins orange with black spots. Peritoneum silvery with few black spots.

Body: Somewhat rounded in section (moderately compressed in young). Head subconical and flattened dorsally, distance between the eyes about 1 to 1 1/2 times eye length; eyes large; mouth long (tip of maxilla extending to or past center of eye), terminal (upper jaw slightly extended past lower jaw in young fish), and slightly oblique. Continuous groove separating upper lip from snout; front margin of snout rounded. Most of cheeks covered with ctenoid scales. Opercle with a sharp spine. Teeth on upper and lower jaws, palatines, and head of vomer; sharp long canine-like teeth on jaws and palatines, present on young as small as 3 cm. Pseudobranch well developed. Gill membranes extending forward and not joined to each other or to isthmus. Pectoral fin base strongly oblique (sloping forward at top) and on lower half of body. Pelvic fin insertion under front third of pectoral fin. Distance between inner rays of pelvic fins about equal to width of base of either fin. Ctenoid scales covering



Map 22.4 Distribution of sauger in Alberta.

body. Lateral line almost straight, beginning on upper half of body and at center on caudal peduncle, extending well onto the caudal fin. Caudal fin moderately forked. Lateral-line scales about 85-95. First dorsal fin with 12-15 spines, second dorsal fin with 1 weak spine and 17-21 soft rays (usually 18 or 19); anal fin with 2 weak spines and 11-14 soft rays. Pyloric caeca 3-9, each shorter than stomach length. Vertebrae 43-45.

Size: Maximum length 71 cm and maximum weight 3.8 kg. Sauger are smaller than walleye.

Alberta

The heaviest sauger taken in Alberta weighed 2.5 kg (57.1 cm) and was taken from the Milk River in 1984 by D. Bosch (an angling record). The longest Alberta sauger was 59.6 cm (2.2 kg), also from the Milk River.

Distribution

● Alberta to southern Quebec and eastern Texas to West Virginia.
■ Known in Alberta from North Saskatchewan, Red Deer, Bow, Oldman, St. Mary, South Saskatchewan, and Milk rivers (or at the mouth region of smaller tributaries; see Map 22.4).

Biology

Sauger occur in both lakes and rivers; present in Alberta, however, only in rivers. They appear to be tolerant of silty waters although they feed primarily by sight. Sauger lie on the substrate when inactive (in contrast, walleye swim or rest just above the substrate); this may account for the thickened rounded pelvic fins of older sauger. Feeding occurs mostly on bottom-dwelling fishes and aquatic insects. They spawn in the spring, starting at a water temperature of about 6°C. The diameter of ripe sauger eggs (1.0-1.5 mm) is somewhat smaller than ripe walleye eggs. Young sauger are about 5 mm long when hatched from the egg. Sauger hybridize with walleye in eastern North America and hybrids, which are intermediate in color pattern to the parental species, have been caught in the North Saskatchewan and Red Deer rivers.

Angling

Sauger have not attained a notable status in the province's sport fishery, probably because they are not readily distinguished from their close relative the walleye and are caught by the same techniques used for

walleye. The two species can be distinguished by the careful observer using the features given in the key. The larger silty rivers of central and southern Alberta do offer sauger fishing opportunities. Casting with spoons, lures that resemble small fish, or flies or still-fishing with baited hooks often produce sauger. This species usually does not attack lures or bait aggressively so slow, jerky retrieves are likely to be effective. River backwaters and areas around the mouths of tributary streams are favorite locations for sauger. The Milk River, middle lower reaches of the Red Deer River, and the North and South Saskatchewan rivers make up the sauger fishing streams in the province; sauger are not found in Alberta lakes.

Historical Note

C.H. Smith first described the sauger in 1836 from the Great Lakes region of Canada as *Lucioperca canadensis*. It was first collected in Alberta by G.F. Sternberg in 1915 from the Red Deer River and 1916 at Morrin in the Red Deer River drainage (McAllister 1962). Whitehouse (1919) speculated upon their occurrence in Alberta while Paetz (1958) was the first to report their presence in the province from the Red Deer and Milk rivers.

22.5 Walleye (or Pike perch) *Stizostedion vitreum vitreum* (Mitchill)

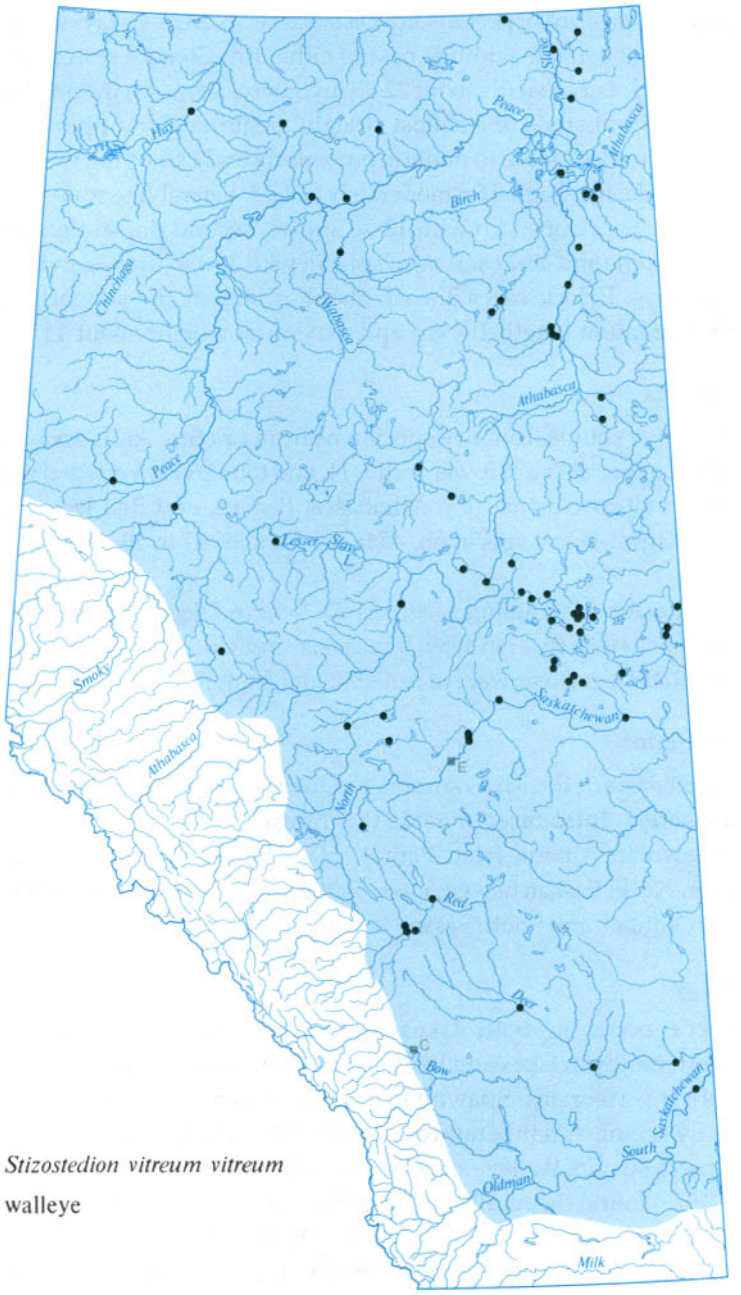
[*Stizo stedion:* to prick, a little breast (sharp pointed throat); *vitreum:* glassy, pertaining to the eye]

Walleye from Wolf Lake. M.J. Paetz.

Description

Color: Yellow-olive dorsally, brassy silvery laterally with numerous yellowish spots, white ventrally. Usually 6-8 indistinct oblong dusky vertical bars on body, large dusky blotch near hind end of spinous dorsal fin (except in very young), no definite spots in rows. Dark spot at base of pectoral fin, white tinge on anterior tip of anal fin and lower lobe of caudal fin. Peritoneum silvery with few black spots.

Body: Somewhat rounded in section (moderately compressed in young). Head moderately deep and flattened dorsally, distance between the eyes about 3/4 to 1 times eye length; eyes large; mouth large (tip of maxilla extending past center of eye), terminal (upper jaw slightly extended past lower jaw in young fish), and slightly oblique. Continuous groove separating upper lip from snout; front margin of snout rounded. Cheeks scaleless or with only a few ctenoid scales. Opercle with a sharp spine. Teeth on upper and lower jaws, palatines, and head of vomer; sharp long canine-like teeth on jaws and palatines, present in young as small as 3 cm. Pseudobranch well developed. Gill membranes extending forward and not joined to each other or to isthmus. Pectoral fin base strongly oblique (sloping forward at top) and on lower half of body. Pelvic fin insertion



Map 22.5 Distribution of walleye in Alberta.

under front third of pectoral fin. Distance between inner rays of pelvic fins about equal to width of base of either fin. Ctenoid scales covering body. Larvae with about 22-29 myomeres between the anus and caudal fin. Lateral line almost straight, beginning on upper half of body, curving down to midline posteriorly and extending well onto the caudal fin. Caudal fin moderately forked. Lateral-line scales about 85-100. First dorsal fin with 12-16 spines, second dorsal fin with 1 weak spine and 18-22 soft rays; anal fin with 2 weak spines and 11-13 soft rays. Pyloric caeca 3, each about as long as the stomach.

Size: Maximum length 104 cm and maximum weight about 11.3 kg.

Alberta

Gillraker counts from five specimens from Lac Ste. Anne are as follows: upper arch 6-8, lower arch 7-14, and total 16-21. Vertebral number in 69 specimens from Athabasca, Beaver, and Red Deer river drainages: 44 in 1 specimen, 45 in 17, 46 in 39, 47 in 10, 48 in 1, and 49 in 1.

The Alberta angling record is 73.7 cm (6.7 kg) from the North Saskatchewan River in 1989. Similar size individuals are known from the Red Deer River west of Innisfail and from the Athabasca River.

Distribution

● Northeastern British Columbia to Quebec and Nebraska to northern Georgia. Introduced outside this range.

■ Known in Alberta from Petitot, Hay, Slave, Peace, Athabasca, Beaver, North Saskatchewan, lower Battle, lower Red Deer, lower Bow, lower Oldman, and South Saskatchewan river drainages (see Map 22.5).

Biology

Walleye occur in both lakes and rivers; in Alberta they are predominantly in lakes and large rivers. They feed mostly on fish and aquatic invertebrates. Spawning occurs in streams or on lake bottoms in early spring at temperatures of about 5°C, usually before suckers and perch spawn. Walleye spawning usually ends by mid-May. Kristensen (1979) found the number of eggs in 42-49 cm walleye from Richardson Lake to range between about 21,000-94,000. Most males are mature by five years of age while most females mature at age six or older. Individuals may live to be at least 14 years old. Walleye are known to hybridize with sauger in eastern North America; hybrids are known from the North Saskatchewan and Red Deer rivers.

At least three types of tapeworms occur as adults in the walleye intestine, including *Triaenophorus stizostedionis* obtained from eating infected trout-perch. Walleye are also host to a variety of other parasites, including the larvae of the broad tapeworm, *Diphyllobothrium* (= *Dibothriocephalus*) *latum* which was studied by Anthony (1967) in Iosegun Lake. These larvae, which are found in the flesh, are the only fish parasites in Alberta known to infect humans (where they occur in the adult form in the small intestine). Proper cooking of the fish, of course, eliminates all danger.

Angling

Walleye are important in the sport and commercial fishery and have an excellent tasting white flesh. They are probably more highly prized by fisherman for their eating qualities than for their sporting qualities. They are, however, a good game fish. They are taken most frequently on casting or spinning tackle using artificial lures such as feathered or hair jigs, plugs resembling minnows, flies, and baited hooks. During the winter, still-fishing with bait or jigs fished with an up and down motion is often productive. The preferred fishing time for walleye is in the late afternoon or evening when the light is fading since walleye tend to shun bright light. They are frequently taken along rocky or sandy shoals of lakes during the spring and summer, although in late fall and early winter they are frequently found in deeper water. Our larger rivers, North Saskatchewan, Red Deer, Peace, and Athabasca, have a history of producing some of the largest walleye taken in the province.

As a result of reduced catch rates by anglers, the province has been involved since 1985 in collecting walleye spawn and rearing the young for stocking in various waters as part of its Walleye Enhancement Program. However, effective management of natural populations of this species and of sauger is necessary to avoid over-exploitation.

Walleye are unfortunately called pickerel by most Albertan fisherman (the true pickerel is a member of the pike family).

Historical Note

S.L. Mitchill first described the walleye in 1818 from Cayuga Lake, New York as *Perca vitrea*. It was first noted in Alberta by Whitehouse (1919) from various localities along the Red Deer River. Kendall (1924) noted it from Lake Athabasca.

The other nominal subspecies of the walleye (or yellow walleye), the Blue pike (or blue walleye) *Stizostedion vitreum glaucum* Hubbs of lakes

Erie and Ontario, is probably extinct. It is quite proper to refer to our form by only the species name, *S. vitreum* (Mitchill).

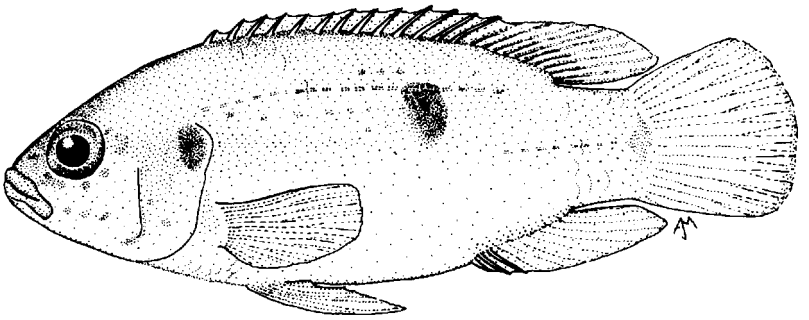
23 Cichlid Family—Cichlidae

CICHLIDS ARE NATIVE to southern North America (Texas and southward), Central America, South America, Africa, and parts of southern Asia. They are well known for the large number of species confined to certain African lakes. With over 700 species, the family is the fourth largest of the 445 fish families. Many species are popular aquarium fish (e.g., freshwater angelfishes, discusfish, Jack Dempsey, oscar, and various African cichlids). Some, such as various species of *Tilapia* (including *Sarotherodon* and *Orechromis*) are commonly used in fish culture for food. The largest cichlid reaches 80 cm in length but most are under 25 cm. One species has been introduced in Alberta into hotsprings near Banff.

Cichlids have a laterally compressed body and a long dorsal fin composed of spines and soft rays. There is a single nostril on each side of the snout and the lateral line exists in two parts. The family is relatively closely related to the marine damselfishes.

23.1 African Jewelfish *Hemichromis bimaculatus* Gill

[*Hemi chromis:* half *Chromis* a genus of damselfish; *bi maculatus:* two spotted]



African Jewelfish from Cave and Basin marsh (western end near observation platform), Banff, 4.7 cm standard length.

Description

Distinguished from other Alberta species by the following characters (based on eight specimens from the Cave and Basin Hot Springs marsh near Banff; see also Section 23, Cichlid Family): number of scales along side 24-27 (and about 7-9 scales along upper, anterior lateral line and 17-19 scales along lower, posterior lateral line); dorsal fin with 13 or 14 spines and 10 or 11 soft rays; anal fin with 3 spines and 8 or 9 soft rays. The jewelfish is one of the most colorful fish in Alberta. The body and head may be green and red with colorful spots. Breeding individuals are a bright red. There is a conspicuous black spot on the tip of the gill cover, another in the middle of the body, and often there is one on the caudal peduncle.

Maximum length noted in Alberta 6.9 cm standard length (8.7 cm total length); much larger individuals have been seen.

Distribution

- Native to western, central, and northeastern Africa.

■ Found in Alberta only in the lower reaches of West Basin Spring and from areas of the marsh adjacent to the fish observation platform at the Cave and Basin near Banff. Not otherwise known in Canada.

Biology

We know little of the biology of this species in Alberta. However, a great deal is known about the species, which lays eggs on the substrate and provides parental care to the young, from aquarium studies and field studies in Africa. Individuals with numerous young have been observed at the Cave and Basin. Territoriality is very pronounced. Individuals collected in October had eaten the following items: snails, amphipods, algae (including the filamentous greens *Spirogyra* and *Mougeotia*, identified by Dr. M. Hickman, the University of Alberta), diatoms, insect larvae (including a soldier fly larvae identified by Dr. H.F. Clifford, the University of Alberta), fish remains, and much unidentifiable material, perhaps including mites. High mortality was noted when water levels were low in the marsh.

Historical Note

T. Gill first described the African jewelfish in 1862 from west Africa. It was first noted in Alberta in a 1976 manuscript report of W.D. Reynolds (Nelson 1983).

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Appendix I

Species Introduced or Collected in Alberta But Not Known to Be Established and Species Found in Adjacent Areas

THE FOLLOWING SPECIES have either been introduced or collected in Alberta but appear not to be established, or they are found in adjacent areas. The primary references to the fish fauna in adjacent areas are the following: Atton and Merkowsky (1983) for Saskatchewan; Carl, Clemens, and Lindsey (1967) for British Columbia; Brown (1971) for Montana; McPhail and Lindsey (1970) and Stein et al. (1973) for the Northwest Territories. Species known to have been introduced at the Banff Cave and Basin Hot Springs and subsequently collected but not surviving now are included here (based on Nelson 1983); species introduced to the hot springs which have not survived for long are excluded.

Sturgeon Family—Acipenseridae

White sturgeon—*Acipenser transmontanus* Richardson

The white sturgeon lacks distinct median plates behind the dorsal and anal fins; there are about 28-30 dorsal fin rays. This species occurs as close to Alberta as the Fraser and Columbia-Kootenay river systems of British Columbia

Pallid sturgeon—*Scaphirhynchus albus* (Forbes and Richardson)

Shovelnose sturgeon—*S. platorynchus* (Rafinesque)

Both these species have a long narrow caudal peduncle and lack a spiracle. They occur in the Missouri River system of Montana.

Gar Family—Lepisosteidae

Shortnose gar—*Lepisosteus platostomus* Rafinesque

This species occurs in Montana in the Missouri River but appears

to be confined to below Fort Peck Reservoir; it is thus not likely to be found in the Milk River.

Freshwater Eel Family—Anguillidae

American eel—*Anguilla rostrata* (Lesueur)

One specimen was angled in the South Saskatchewan River at the Sandy Point Bridge (Radford 1972). The eel was 94 cm in length, 1420 g in weight, and about 23 years in age. It was probably a survivor of introductions made in Saskatchewan in 1953. This species is native to the North Atlantic Ocean and its tributary rivers; it spawns in the Sargasso Sea area, but it cannot reproduce in fresh water.

Minnow Family—Cyprinidae

Goldfish—*Carassius auratus* (Linnaeus)

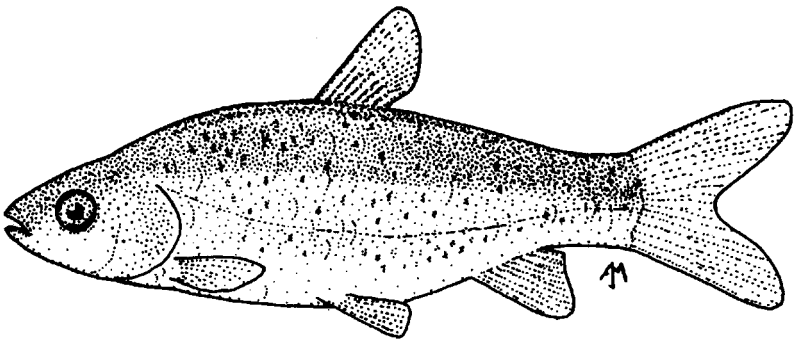
Several illegal releases of goldfish have been made in Alberta by the public. They occur in many garden ponds; Henderson Lake in Lethbridge usually has a modest number. This species can be distinguished from other cyprinids in having about 18 dorsal fin rays preceded by a spinous ray, 5 anal fin rays preceded by a spinous ray, no barbels on upper jaw, fewer than 32 lateral-line scales, and pharyngeal teeth in one row of 4-4.

Common carp—*Cyprinus carpio* Linnaeus

Carp occur in neighboring British Columbia, Saskatchewan, and Montana. They were introduced into North America from Europe and Asia. They are found in Alberta in indoor display tanks, especially varieties of the koi, the Japanese colored common carp. This species is able to tolerate a wide temperature range. This species can be distinguished from other cyprinids in having two barbels on each side of upper jaw, more than 16 dorsal fin rays preceded by a spinous ray, 5 anal fin rays preceded by a strong toothed spine, pharyngeal teeth in 3 rows of 1,1,3-3,1,1. They can grow to about 70 cm (rarely longer).

Grass carp—*Ctenopharyngodon idella* (Valenciennes)

This species of cyprinid is native to eastern Asia (e.g., Amur River region) and has been introduced into many parts of the world because of its ability to control aquatic vegetation and for its value as a food fish. There have been numerous studies on this species



Drawing of a young grass carp from the Alberta Environmental Centre in Vegreville.

(Winfield and Nelson, 1991). The first introductions into Canada were in 1988 and 1990 when grass carp were imported from Florida as 4 day-old triploid fry by the Committee on Biological Control of Aquatic Vegetation (a collaborative research committee made up of representatives from various Provincial and Federal Government Departments, Lethbridge Community College, and the Alberta Irrigation Projects Association). The fish were reared in quarantine for the first year at the Alberta Environmental Centre in Vegreville. Functionally sterile grass carp were stocked in 1989 in dugouts in southern Alberta near Lethbridge and released in 1990 and 1991 into a controlled reach of irrigation canal, within the boundaries of the landlocked Pakowki Lake drainage (B.F. Bidgood, K. Smiley, and D. Lloyd, personal communication). This is part of a study to determine if triploid grass carp could be used to control aquatic vegetation in irrigation canals within the thirteen irrigation districts of Alberta. The sterile individuals are certified triploids, that is, they have three sets of chromosomes (72 chromosomes in total) instead of the normal two sets (48 chromosomes). Functionally sterile grass carp have been introduced into irrigation canals in adjacent Montana; they are widely distributed in the United States and illegal stocking of diploid fish has occurred with evidence of successful reproduction (Robins et al. 1991). It was suggested in the early 1970s that grass carp should be introduced into Wabamun Lake, but there was concern that it might escape into the North Saskatchewan River as well as concern that over-control of aquatic vegetation in Wabamun Lake

could have a negative impact on other fish by destroying habitat and food supplies.

Grass carp, sometimes referred to as "white amur," can be distinguished from other cyprinids in Alberta by their large scales (about 38-44 along the lateral line), short dorsal fin (8-10 soft rays) inserted slightly ahead of the pelvics, and the absence of barbels. In addition, their short anal fin is placed relatively far back as in suckers and the pharyngeal teeth are in 2 rows, usually 2,5-5,2 or 2,5-4,2. They crush plants with their pharyngeal teeth and have a long gut; however, they cannot digest whole plant cells. Individuals of this species attain exceptionally large sizes, some are known to reach over 1 m.

Peamouth—*Mylocheilus caurinus* (Richardson)

Peamouth occur close to Alberta in eastern British Columbia in the Peace, Fraser, and Columbia river drainages. It was reported in Alberta at Athabasca on the Athabasca River by McPhail and Lindsey (1970) on the basis of one specimen seined in 1957. Recent collecting, the known distribution of the species, and conversation with the senior collector at the site, Dr. Gordon Hartman, leads us to doubt the validity of the locality information for the specimen. We wonder if the specimen in question might have been mixed with other museum specimens. Although the species might be expected from the Peace River of Alberta, all collecting has failed to find it. Peamouth can be distinguished from other cyprinids in having a small barbel at end of upper jaw, front of dorsal fin opposite or in front of pelvic fin insertion, upper jaw extending forward slightly over the small horizontal mouth, more than 67 lateral-line scales, lateral line complete, pharyngeal teeth 1,5-5,1, tip of dorsal fin somewhat pointed, two dark lateral bands in juveniles and adults, and fork length up to 32 cm.

Golden shiner—*Notemigonus crysoleucas* (Mitchill)

The golden shiner occurs in eastern Saskatchewan and in Montana in Missouri drainage. This deep-bodied minnow with the origin of the dorsal fin behind the insertion of the pelvic fins and having a long-based anal fin is similar in appearance to the redside shiner. However, the golden shiner has only 44-54 scales along the strongly decurved lateral line and pharyngeal teeth 0,5-5,0.

Blacknose shiner—*Notropis heterolepis* Eigenmann and Eigenmann

The blacknose shiner occurs in Saskatchewan and has been reported from Alberta; however, we lack verifiable records. It can be distinguished from other cyprinids in Alberta in having a black lateral band extending around snout but not on lower jaw, the lateral line is incomplete, pharyngeal teeth 0,4-4,0, and the mouth is almost horizontal and slightly subterminal.

Blacknose dace—*Rhinichthys atratulus* (Hermann)

Specimens of this species reported from Lake Minnewanka by Rawson (1939b) are most likely hybrids of *Couesius plumbeus* and *Rhinichthys cataractae*. The species does occur in the Saskatchewan River drainage in eastern Saskatchewan and in Manitoba.

In addition, the Columbia River drainage in British columbia has three other species of *Rhinichthys*: *R. falcatus* (leopard dace), *R. osculus* (speckled dace), and *R. umatilla* (Umatilla dace). The Umatilla dace may be only a variant of the speckled dace (Robins et al. 1991).

Trout Family—Salmonidae

Blackfin cisco—*Coregonus nigripinnis* (Gill)

This cisco, native to parts of the Great Lakes basin, was reported in the Alberta portion of Lake Athabasca by Dymond and Pritchard (1930). Its presence in Alberta cannot be accepted without verification, and the material identified as *C. nigripinnis* probably represents the cisco *C. artedi*.

Chum salmon—*Oncorhynchus keta* (Walbaum)

This species of Pacific salmon is occasionally reported a short distance from the Alberta border in the Northwest Territories at Fort Smith. It can be distinguished from other *Oncorhynchus* as it has 19-26 gillrakers, 140-186 pyloric caeca, absence of distinct black spots on back and fins, and young with 6-10 oval parr marks scarcely extending below the lateral line.

In addition, one specimen of chinook salmon, *O. tshawytscha*, has been taken in the Liard River at Fort Liard, Northwest Territories, a site from which chum salmon are also known (McLeod and O'Neil 1983).

Coho salmon—*Oncorhynchus kisutch* (Walbaum)

Coho were stocked in Cold Lake between 1970 and 1972 with Alaska and Oregon stock. Many individuals were angled in Alberta and Saskatchewan. Reproduction did not occur and all individuals were probably gone by 1976. A study of their biology is found in Leong (1975) and Roberts (1975b). It can be distinguished from other *Oncorhynchus* in having 19-25 gillrakers, 45-80 pyloric caeca, black spots on the back and usually on the upper lobe of caudal fin, and young with long narrow parr marks which extend well above and below the lateral line, a reddish brown tail fin, and an anal fin with elongate white first finrays followed by a dark stripe and a concave margin.

Kokanee—*Oncorhynchus nerka* (Walbaum)

Kokanee were stocked in the 1960s in West Twin, Phyllis, Twin, Narrow, Chickakoo, and Summit lakes and in Glenmore Reservoir (Paetz and Nelson 1970). Reproduction did not occur at any of these localities, with the possible exception of limited reproduction in Summit Lake near the Crowsnest Pass on the border with British Columbia, and the species no longer exists in the province. Kokanee are the freshwater form of *O. nerka;* sockeye salmon are the anadromous form.

Atlantic salmon—*Salmo salar* Linnaeus

This species was introduced into Sawback Creek (1959), Cascade River (1959-1963), and Lake Minnewanka (1915-1923, 1963) in Banff National Park, and into Moab (1961), Celestine (1962), Pyramid (1917, 1961), and Patricia (1962) lakes in Jasper National Park. Reproduction is not known to have occurred. At least five specimens were obtained from Lake Minnewanka between 1964 and 1969. In addition, many were taken by anglers from a borrow pit west of Banff where fry had been planted (Ward 1974). This species can be distinguished from other *Salmo* and from Pacific trout of the genus *Oncorhynchus* in having the deeply forked caudal fin, no distinct black spots on the caudal and adipose fins, few or no spots below the lateral line, weakly developed teeth on the shaft of vomer in adults, and young with reddish spots on the lateral line between parr marks (similar to brown trout young) but without orange coloration on the adipose fin.

Arctic char—*Salvelinus alpinus* (Linnaeus)

Arctic char are native to northern parts of the Northern Hemisphere such as Iceland, northern Europe (including the British Isles), northern Asia, and northern North America from Alaska to Maine. They occur in some coastal areas and occur on islands in the Canadian Arctic Archipelago (including Lake Hazen on Ellesmere Island, the most northern large lake in the world). Quebec red trout (a variety of *S. alpinus*, that is given specific or subspecific status by some, namely *S. marstoni or S. alpinus marstoni*), were introduced into Upper and Lower Block lakes (1957) and Third Vermilion Lake (1959) in Banff National Park. Reproduction is not definitely known to have occurred. In 1988, Arctic char were imported from Manitoba by a commercial fish farmer and similar imports will no doubt be made in the future. See Biology in Section 16.4 Brook Trout for information regarding the introduction of hybrids between that species and Arctic char (= Quebec red trout). It was formerly believed that the char introduced into Chester Lake was Arctic char (see Historical Note in Section 16.13 Northern Dolly Varden). Northern Dolly Varden and Arctic char may be distinguished by the following characters in respective order: pyloric caeca usually fewer than 36 vs more than 36; red spots usually smaller than eye pupil (and numerous) vs many of the spots being larger than diameter of eye pupil (and relatively few); mature males with well-developed kype vs not having a well-developed kype.

Inconnu—*Stenodus leucichthys* (Güldenstadt)

The inconnu, or cony as it is sometimes called, is widespread in Arctic drainages in Eurasia and North America. This northern fish comes close to Alberta in the Liard River drainage of British Columbia and the Slave River (near Fort Smith) and Hay River of the Northwest Territories. It reaches relatively large sizes and unlike other coregonines, the adults feed mainly on other fish. It forms an important fishery in Great Slave Lake and there is a modest market for the fish in the United States (where it is smoked), via the Freshwater Fish Marketing Board. It differs from other Coregoninae in having the lower jaw projecting beyond the upper jaw (cisco-like), very short teeth on the jaws and prevomerpalatines, two flaps on each nostril, fewer than 25 gillrakers, and an anal fin with 13-17 rays.

Livebearer Family—Poeciliidae

Guppy—*Poecilia reticulata* Peters

This popular aquarium fish, native to northern South America and some Caribbean Islands, was taken in large numbers in the marsh at the outflow of Cave and Basin Hot Springs, Banff, in 1968, where it was probably introduced by local aquarists (McAllister 1969). It is no longer present at this site. It can be distinguished from other poeciliids in Alberta as it has 7 or 8 dorsal fin rays, 26-28 lateral-line scales, no spots on the caudal fin, and the origin of the dorsal fin is even with or behind the origin of the anal fin.

Green swordtail—*Xiphophorus helleri* Heckel

This species was taken in the marsh at the outflow of Cave and Basin Hot Springs, Banff, in 1968, where it was probably introduced by local aquarists (McAllister 1969). It is no longer present. It can be distinguished from other poeciliids in Alberta as it has 11-14 dorsal fin rays, 26-30 lateral-line scales, the origin of dorsal fin is in front of origin of the anal fin, and the lower rays of the caudal fin in mature males forms an elongate spike.

Sculpin Family—Cottidae

Prickly sculpin—*Cottus asper* Richardson

This species occurs in the Peace, Fraser, and lower Columbia river drainages in British Columbia. It can be distinguished from other cottids as it has one pore at the tip of the chin, a distinct dark oval spot at the posterior edge of the first dorsal fin, the upper spine on preopercle is long but is only slightly curved, the head is rounded in profile, there is a complete lateral line, there are more than 14 soft rays in the anal fin (15-19), and it has teeth on the palatine bones.

On 8 June 1989, B. McTague and G. Joseph, under the direction of L. Hildebrand and all from R L & L Environmental Services Ltd., caught one specimen of the prickly sculpin (see p. 383) in the Peace River in Alberta 3 km upstream from the confluence of the Notikewin River (about 150 km downstream by river from the town of Peace River)(reported by Roberts 1990). This specimen (UAMZ 6958) is 9.4 cm SL (11.4 cm total length) and has a dorsal fin with 8 spines and 21 soft rays and an anal fin with 17 soft rays. There are dense prickles on the sides of the body except for the posterior portion. While this specimen could have been carried downstream from British Columbia

Prickly sculpin from Peace River near mouth of Notikewin River. Photo courtesy of R L & L Environmental Services.

it is also quite possible that the species is established in Alberta in the Peace River or in tributaries such as the Notikewin.

Torrent sculpin—*Cottus rhotheus* (Smith)

The torrent sculpin occurs in Columbia and Kootenay river drainages of British Columbia. It can be distinguished from other cottids as it has two pores at the tip of the chin, the lateral line is complete, it has fewer than 14 soft rays in the anal fin, and it has teeth on palatine bones.

Sunfish Family—Centrarchidae

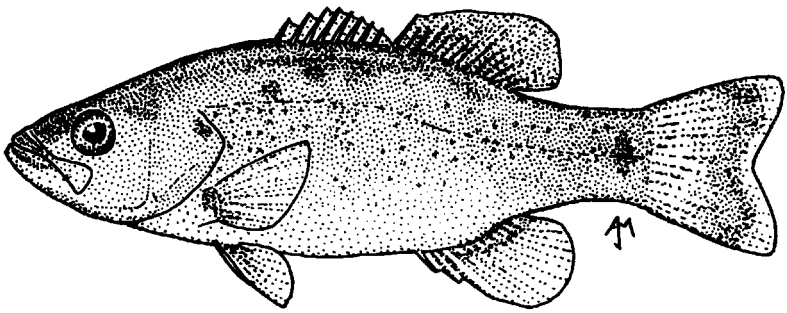
Pumpkinseed—*Lepomis gibbosus* (Linnaeus)

One pumpkinseed was caught in 1979 in Lee Lake, in the Oldman River drainage east of Bellevue by individuals from Lethbridge Community College (F. Bishop, personal communication). The source of this illegal introduction may have been from established populations to the west in the Creston Valley, Kootenay River drainage, British Columbia. Lee Lake is also the site of an illegal introduction of redside shiner.

Smallmouth bass—*Micropterus dolomieu* Lacepède (formerly spelt *M. dolomieui*)

Largemouth bass—*M. salmoides* (Lacepède)

In 1908 bass were introduced into Lake Minnewanka near Banff and into Sylvan, Gull, Pine, Buffalo, and Cooking lakes in central



Drawing of a smallmouth bass.

Alberta. In 1924 bass were introduced into Ministik Lake, southeast of Edmonton. Several years later, largemouth bass were released into Pigeon and Wabamun lakes and Lac la Nonne, all three lakes in the Edmonton area. In these introductions, yearling and two year old bass were used. Some were later caught by anglers, but there was never any evidence of reproduction. More recently, smallmouth bass were introduced into Island Lake (north of Smoky Lake townsite) in 1977-1979, 1981, and 1984. They have survived over several winters, and some have been caught by anglers. The record size is a 43.1 cm specimen weighing 1.8 kg (Scammell 1990). There is evidence of reproduction; in July 1989 individuals were caught that are young of the introduced fish but there is no evidence of their continued survival (M.G. Sullivan, personal communication, 1991).

Members of this family are distinguished from other species by having three or more spines in the anal fin and teeth on the vomer. In addition, smallmouth bass can be distinguished from yellow perch, walleye, and sauger—the only species in Alberta that they are likely to be confused with—by having the two dorsal fins joined by a membrane so it appears as if there is one long continuous dorsal fin and in having 68-78 lateral-line scales. As the common names imply, smallmouth bass have a smaller mouth than largemouth bass; in the former species the upper jaw does not extend past the eye whereas in the latter it does extend past the eye.

Perch Family—Percidae

Johnny darter—*Etheostoma nigrum* Rafinesque

This darter occurs in much of Saskatchewan and further east. There are no verifiable records of its presence in Alberta. It differs from other *Etheostoma* as it has protractile premaxillaries (no frenum), a single anal spine (instead of two), x-or w-shaped spots on the sides of the body, and a complete lateral line extending onto the caudal peduncle.

Drum Family—Sciaenidae

Freshwater drum—*Aplodinotus grunniens* Rafinesque

This species has been collected in a stream in the South Saskatchewan River system in southwestern Saskatchewan and it occurs in the Missouri River system in Montana. It is found throughout much of the Mississippi River system and extends as far south as Guatemala. Freshwater drum have distinctive molarlike crushing pharyngeal teeth on fused pharyngeal arches, first dorsal fin with 8 or 9 spines and second with one spine and 25-33 branched rays, and anal fin with 2 spines (second greatly enlarged) and 7 branched rays.

Cichlid Family—Cichlidae

Convict cichlid—*Cichlasoma nigrofasciatum* (Günther)

This species was caught in the marsh at the outflow of Cave and Basin Hot Springs, Banff, in 1968 (McAllister 1969), where it had been introduced by local aquarists. It has not been seen since and is undoubtedly extirpated.

Freshwater angelfish—*Pterophyllum scalare* (Lichtenstein)

This species was reported as being present in the marsh at the outflow of Cave and Basin Hot Springs, Banff, in 1968 (McAllister 1969), where it had been introduced by local aquarists. It has not been seen since and it probably did not survive for long.

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Appendix II

Features of Some Alberta Lakes[1]

	Location		
Liard drainage			
Bistcho		NW	High Level
Peace drainage			
Utikuma		N	Lesser Slave
South Wabasca		NE	Lesser Slave
North Wabasca		NE	Lesser Slave
Legend		NW	Fort McMurray
Athabasca drainage			
Amethyst		SW	Jasper
Maligne		SE	Jasper
Lesser Slave		NE	Valleyview
Calling		N	Athabasca
Lac la Biche		E	Athabasca
Namur		NW	Fort McMurray
Unnamed	24 km	NE	Namur L.
Athabasca[2]		N	Fort McMurray
Beaver drainage			
Beaver		E	Athabasca
Whitefish		NE	St. Paul
Moose		W	Bonnyville
Cold		NE	St. Paul
North Saskatchewan drainage			
Abraham[3]		SW	Nordegg
Swan		W	Red Deer
Wabamun		W	Edmonton
Lac St. Anne		NW	Edmonton
Astotin		E	Edmonton
Battle drainage			
Pigeon		SW	Edmonton
Red Deer drainage			
Snowflake		N	Banff
Gleniffer[3]		SW	Red Deer
Sylvan		W	Red Deer
Gull		NW	Red Deer
Bow drainage			
Boulder		N	Lake Louise
Bow		NW	Banff
Minnewanka[3]		E	Banff
Upper Kananaskis[3]		W	Calgary
Lower Kananaskis[3]		W	Calgary
Oldman drainage			
Waterton		SW	Cardston

[1]Information from numerous sources, based primarily on Mitchell and Prepas (1990) and other publications listed in the References. Several lakes have been added from the first edition and measurements revised and converted to metric units. Data for Abraham Lake from TransAlta Utilities; that for Gleniffer Lake from Survey

Surface Area Sq. km	Elevation m	Maximum Depth m	Average Depth m
381	552	7.0	3.7
288	644	5.5	1.7
50	546	3.0	1.5
99	544	15.8	5.8
17	789	11.0	5.8
4.7	1966	21.0	7.3
22	1664	96.0	40.2
1160	577	20.5	11.4
138	594	18.3	?
234	540	21.3	8.4
44	723	28.0	13.1
14	686	64.0	15.8
7770	209	124	20
33	599	15.2	7.1
30	577	42.7	13.1
41	533	19.8	5.6
373	535	99.1	49.9
55	1321	91.4	31.8
2.1	1210	11.6	5.6
82	724	11.0	6.3
55	723	9.9	4.8
5.7	711	7.0	3.0
97	849	9.1	6.2
0.08	2324	12.8	6.1
18	948	33.0	12.0
43	938	18.3	9.6
81	900	8.2	5.4
0.08	2499	?	?
3.4	1981	45.1	17.7
21	1475	99.0	51.8
7.8	1702	106	32.0
5.3	1667	42.0	13.1
9.6	1277	135	69.2

Branch, Alberta Environment. Data in some cases is approximate only. Measurements can vary due to differences in lake level within and between years.
[2]The data is for the entire lake; the portion of lake in Alberta has an area of 2305 sq. km.
[3]The reservoir at high water level; Abraham Lake is behind the Bighorn Dam and Gleniffer Lake is behind the Dickson Dam.

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Appendix III

Discharge of Major Alberta Rivers (data to 1988)

River and Locality	Approx. lat N.	Approx. long W.	Drainage Area (km^2)
Slave at Fitzgerald	59°52′	111°35′	606 000
Peace at Peace Point	59°07′	112°25′	293 000
Peace at Peace River	56°14′	117°18′	186 000
Hay near Meander River	59°09′	117°38′	36 900
Athabasca below Fort McMurray	56°47′	111°24′	133 000
Athabasca at Hinton	53°24′	117°35′	9 780
Smoky at Watino	55°43′	117°37′	50 300
Beaver at Cold Lake Reserve	54°21′	110°13′	14 500
N. Saskatchewan at Edmonton	53°32′	113°29′	28 000
N. Saskatchwan near Rocky Mountain House	52°23′	114°56′	11 000
Red Deer below Burnt Timber Creek	51°39′	115°01′	2 250
Red Deer at Drumheller	51°28′	112°42′	24 800
Battle near Saskatchewan Border	52°51′	110°01′	25 000
Bow at Calgary	51°03′	114°03′	7 860
Bow at Banff	51°10′	115°34′	2 210
Oldman near Lethbridge	49°42′	112°52′	17 000
S. Saskatchewan at Medicine Hat	50°02′	110°40′	56 400
Milk at eastern crossing of Internatl. Boundary	48°59′	110°28′	6 490

*Average Discharge for these 3 rivers calculated from March to October inclusive
Maximum/Minimum Daily Discharge are for entire period of record (varying from 10 to 80 years)

cms-cubic meters per second
dam^3-cubic decameters

Average Annual Discharge (cms)	Maximum Daily Discharge (cms)	Minimum Daily Discharge (cms)	Total Volume Discharge (dam^3)
3 390	11 200	530	107 000 000
2 050	11 900	272	66 300 000
1 800	14 100	180	57 000 000
111*	878	0.05	2 360 000
665	4 700	88.6	21 000 000
171	1 200	10.8	5 410 000
358	8 180	14.0	11 300 000
22.6	612	0.37	712 000
213	4 640	6.23	6 730 000
166*	3 680	27.9	3 520 000
19.7	250	2.00	620 000
52.31	130	1.53	1 650 000
7.47	92.7	0.145	236 000
90.9	1 160	3.48	2 870 000
39.6	377	3.62	1 250 000
84.3	2 890	2.12	2 660 000
195	4 080	8.50	6 150 000
14.6*	211	0.00	308 000

The total annual inflow of water into Alberta from British Columbia, Montana and Saskatchewan is approximately 71 947 700 dam^3 (average, several years up to and including 1986).

The total annual outflow of water into Northwest Territories, Saskatchewan, Montana, and British Columbia is approximately 126 582 600 dam^3 (average, several years up to and including 1986).

Data supplied by the Hydrology Branch, Alberta Environment and collected by the Water Resources Branch of Environment Canada.

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Appendix IV

Metric and Imperial Unit Conversions

IN THE TEXT we generally give only metric measurements. The following conversions will allow the reader to convert figures between metric and Imperial units.

Length	1 centimeter (cm)	= 0.3937 inches
	1 meter (m)	= 39.37 inches
	1 kilometer (km)	= 0.62 miles
	1 inch	= 2.54 cm or 25.4 millimeters (mm)
	1 foot	= 0.3048 m or 30.48 cm
	1 mile	= 1.61 km
Weight	1 gram (g)	= 0.0353 ounces
	1 kilogram (kg)	= 2.205 pounds
	1 ounce	= 28.35 g
	1 pound	= 0.454 kg or 454 g
Area	1 hectare (ha)	= 2.47 acres
	1 square kilometer (km^2)	= 0.386 square miles = 100 ha
	1 acre	= 0.405 ha
	1 square mile	= 2.59 km^2 = 640 acres
Volume (for river discharge)		
	1 cubic meter	= 35.31 cubic feet
	1 cubic decameter (dam^3)	= 35314 cubic feet
	1 cubic foot	= 0.0283 cubic meters
	1 acre foot	= 1234 cubic meters

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Glossary

Adipose eyelid—a fixed fatty tissue extending around the margin of the eye or covering the eye, found in some bony fishes such as goldeye, mooneye, and most species of the trout family. The eyes of fishes are lidless except for a nictitating membrane in some sharks and the adipose eyelid of some bony fishes, structures whose function is largely unknown.

Adipose fin—a small fleshy rayless fin on the back between the dorsal and caudal fins in members of the trout, catfish, and trout-perch families. This fin also occurs in members of several groups not found in Alberta, for example, in the characins or tetras.

Ammocoete—the larva of lampreys (family Petromyzontidae), usually buried in the substrate of streams until metamorphosis occurs to the adult form.

Anadromous—a life-history pattern where the fish spawns in fresh water but part of the rest of the life cycle is spent in the ocean.

Anal fin—a median fin on the lower part of the body behind the anus and between the pelvic fins and the caudal fin.

Anterior—the front part or in front of another part.

Antrorse—turned forward; used to describe the condition where the premaxillary bone is turned forward, resulting in a "sharp" snout, as in ciscoes. See also *Retrorse*.

Barbel—an elongate fleshy process near the mouth provided with the sense of touch or smell. It is found in sturgeon, catfish, burbot, and some minnows.

Basal end of a fin—the point where the most posterior ray joins the body.

Basal length of a fin—the length of the fin where it is attached to the body; see Chapter 7, Fig. 7.3a.

Basibranchials—a series of median bones behind the tongue and between the gills; in some fish species they bear teeth (sometimes termed the "hyoid" teeth).

Benthic—living on or near the substrate of a lake or stream. Benthic fishes such as sturgeon, suckers, sculpins, and darters primarily live close to the substrate (or bottom) as opposed to living near the surface or in the water column well above the substrate.

Branchial arches—the gill arches, consisting of the paired pharyngobranchials, epibranchials, ceratobranchials, hypobranchials, and the median basibranchial. Most of the gill filaments and gillrakers are attached to the epibranchials and ceratobranchials.

Branchiostegal rays—long curved bones supporting the gill (branchiostegal) membrane which encloses the gill chamber ventrally; they attach to the epihyal and ceratohyal bones.

Caudal fin—the tail fin (see *Heterocercal* and *Homocercal*).

Caudal peduncle—the portion of the body between the end of the anal fin and the base of the caudal fin; see *Scale counts* and Chapter 7, Fig. 7.3a

Character—a feature of a taxon used to describe that taxon; a diagnostic character is a feature of a taxon used to define or identify that taxon. Characters may be meristic, morphometric, color, or attributes.

Cheek—the area between the eye and preopercle bone (see Chapter 7, Fig. 7.3a,b, for this bone).

Clinal variation—a character gradually changing over a geographic range (i.e., between populations). Such character gradients referred to as clines are typically associated with altitude, latitude, and longitude.

Compressed—flattened from side to side, as in the body of goldeye and lake whitefish.

Concave—curved inward, like the inside of a circle.

Congeneric—belonging to the same genus; refers to species. For example, the mooneye and goldeye are congeneric, both being placed in the genus *Hiodon*.

Conspecific—belonging to the same species; refers to individuals or populations. For example, the various color forms of northern pike are conspecific, all belonging to the species *Esox lucius*.

Convex—curved outward, like the outside of a circle.

Creel—a container used to carry fish that have been kept by anglers. A creel census or survey is a record of the fish caught by anglers.

Crustaceans—invertebrates with gills, shell, appendages, and two pairs of antennae. The freshwater crustaceans in Alberta include species of cladocerans (e.g., *Daphnia*), ostracods, copepods, amphipods, and crayfish.

Ctenoid scale—a scale bearing tiny spines on its posterior portion and feeling rough to the fingers; typical of the perch family.

Cycloid scale—a scale approximately circular in outline, lacking spines and relatively smooth to the fingers; typical of most Alberta fishes.

Decurved—curved downward, as in the lateral line of many minnows (cyprinids).

Depressed—flattened from top (dorsal) to bottom (ventral), as in the head of a spoonhead sculpin. This term may also be used to describe the state of a fin or fin-ray when lying against the body.

Dorsal—pertaining to the back or upper side.

Electrofishing—the use of electricity to capture fish. The electrofishing gear may range in size from a compact unit carried by one person in a back-pack and with two wands (an anode and cathode) to a large unit used from a boat.

Endangered (species)—any indigenous species that is in danger of becoming extinct due to human actions. The term may also be used if the species is in danger of disappearing from a large part of its natural range. Taxonomic units below the species level may also be referred to as endangered. Organizations and government agencies, for example the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), may have slightly different definitions.

Endemic—confined to a given or defined geographic area.

Extant—surviving; applies to a species that still has living representatives (versus extinct). See also *Extirpated*.

Extirpated—to be wiped out of a given area but surviving somewhere. A species is said to be extirpated from an area if it is no longer present in a former part of its range but still exists somewhere.

Eye length—the horizontal length of the exposed eye. This should not be confused with iris length (diameter) which is measured across only the pupil, or with orbit length (diameter) which is measured across the bony margins of the eye socket. It is sometimes referred to as the eye diameter (but this term can be understood to mean the diameter of the entire eye ball); eye length and eye diameter are used synonymously in this book.

Falcate—scythe or sickle-shaped, with a concave margin; as in the trailing edge of the pectoral fin of flathead chub.

Fauna—the animals inhabiting a region. The equivalent term for plants is flora, and the fauna and flora of a region comprise its biota.

Fecundity—usually regarded as the number of eggs in the ovaries that are mature or will mature. This is a common measure of reproductive or spawning potential for the season.

Fish—a vertebrate with gills throughout life and with limbs, if any, only in the shape of fins (not polydactylous limbs; although there may be fin rays there are no digits). Fishes are almost always ectotherms, an animal whose temperature varies with the water temperature; many fishes lack scales and certain fins. The term "fish" is used by us, unlike by some, to include all jawless vertebrates such as the lampreys and such jawed vertebrates as sharks, lung

fishes, and bony fishes. It is thus not what biologists refer to as a monophyletic unit, where all descendants from a common ancestor are included in the term.

The singular "fish" is appropriately used when talking about any number of individuals of the same species while the plural "fishes" is used when discussing individuals of two or more species.

Fontanelle—an opening through the bone on the dorsal part of the head, covered by soft membranous skin.

Fork length (FL)—the straight line distance from the most anterior point of the snout to the central part of the margin of the caudal fin (whether forked or not).

Formalin—a common fixative used for fish. A fixative chemically binds tissues and prevents decay. Formalin is a liquid made from formaldehyde gas and it must be used with the utmost safety precautions so as to avoid breathing the fumes. In research collections fish initially fixed in formalin are usually washed and placed in the preservative isopropyl alcohol or in the fixative ethanol. A preservative prevents bacterial decay but does not bind the tissue and a fish placed only in isopropyl alcohol will not remain intact.

Frenum—a vertical bridge of tissue that crosses over a groove between the upper jaw and snout (the premaxillary groove) and connects the upper lip to the snout thus making the premaxillaries nonprotractile. Present in goldeye, mooneye, longnose dace, pike, salmonids, trout-perch, Iowa darter, and logperch.

Fry—newly hatched fish after the yolk sac has been absorbed. This term is preferably used only for fish in their first few months of growth, and has special meaning when confined to a stage before the fish undergoes some change in biology (e.g., moving from a hatching area to a general residence). However, the term "fry" is sometimes used in referring to any small fish, regardless of age, thereby lacking precision in not necessarily referring to a generally understood specific life-history stage of a particular species either in a hatchery or in the natural environment. The term "juvenile" may be used in place of or in addition to the term "fry" up to the adult stage when reproductive maturity occurs. The term "larvae" is sometimes appropriately used for a young fish but not all fishes have a larval stage—i.e., not all fishes undergo a metamorphosis, a minor or major change to the adult form, but many hatch directly into a juvenile stage (which resembles the adult form). In addition, referring to all small fishes as minnows should be avoided, and there is nothing wrong with referring to small fishes of unknown age as "small fishes".

Fyke net and hoop net—rectangular or conical nets that are set so as to intercept the movement of fish. The fish swim into the trap and then into a holding area with a restricted opening. These nets are often used in research studies when it is important to keep the fish alive.

Genus—a category for a taxon that includes one or more species. *Salmo* and *Salvelinus* are genera of salmonids. See also Chapter 5, Section 5.4.

Gill cover—the operculum; the large thin bones on each side of the head that cover the gills. There are four opercular bones, the preopercle, opercle, subopercle, and interopercle, in each gill cover in most extant jawed fishes; see Chapter 7, Fig. 7.3b.

Gill net—a vertical wall of meshed netting used to catch fish. The fish try to swim through the net but are caught, usually by the mesh slipping behind the gill cover (hence, the fish is said to be "gilled"). Gill nets come in various sizes of mesh, each net therefore being suited to fish of different sizes. The top of the net is kept up by a cork line on top and the bottom is held down by a lead line on the bottom. The net may be set at any depth in a body of water. Gill nets are the common method used by commercial fisherman in Alberta to catch fish.

Gillrakers or **gill rakers**—the structures attached to the front margin of the gill arches (found beneath the gill cover), opposite the gill filaments; they are often slender rodlike projections although the length and shape can vary between species; see Chapter 7, Fig. 7.3c. Unless otherwise stated, counts are made on the first gill arch, which usually must be dissected out, and on the outside or external row if two rows are present.

Glochidia—the larvae of freshwater clams which attach as a cyst to the skin or gill filaments of a fish for part of their life history.

Gonad—the ovary or testis.

Haemal spine—the lowermost spine of a caudal vertebra of a fish.

Head length—the distance from the most anterior part of the head to the most posterior part of the opercular membrane.

Heterocercal caudal fin—a tail fin in which the upper lobe has a distinct fleshy base and is longer than the lower lobe, as in the sturgeon.

Holarctic—a zoogeographic region that includes the Nearctic (North America except for part of southern Mexico) and the Palearctic (Europe, most of Asia, and northern Africa). Organisms that are said to be Holarctic (in distribution) may be expected to occur in most of this area, but not necessarily throughout it.

Holotype—a single specimen designated to represent a species at the time of its description by the author. The holotype serves only as a "name bearer," such that if a species is determined to represent two or more species, the original species name stays with the form represented by the holotype. Holotypes are given special care and are maintained in museums. For various reasons many species do not have a holotype (e.g., the white sucker). For taxonomic purposes there are also many other sorts of "type" specimens (e.g., syntypes, lectotypes, neotypes, and paratypes).

Homocercal caudal fin—a tail fin in which the upper and lower lobes are about equal or the fin is rounded; in all Alberta jawed fishes except the sturgeon.

Hyoid arch—the second visceral arch, occurring between the jaws and the gill arches. The hyoid arch of a bony fish consists of the hyomandibular, symplectic, interhyal, epihyal, ceratohyal, hypohyal, and basihyal (tongue) bones. The branchiostegal rays attach to the epihyal and ceratohyal bones.

Hypural bones or plate—the modified haemal spines of the last few vertebrae on which the caudal fin-rays articulate. The hypural elements are part of the caudal skeleton and are the most posterior part of the axial skeleton; the end of the hypural plate is determined without dissection by moving the tail fin from side to side.

Ichthyology—the scientific study of fishes. In North America this term is usually restricted to studies of a systematic or taxonomic nature (e.g., on the evolutionary relationships of the species and their classification) whereas in Europe it is often used to include the study of any aspect of fish biology (e.g., ecology and physiology), including fisheries management.

Indigenous—native to a geographic area. Rainbow trout are believed to be indigenous to parts of the Athabasca River in Alberta but are not indigenous to other drainages in Alberta; brown trout are not indigenous to North America. See also *Endemic*, *Introduced*, and *Native*.

Infectious pancreatic necrosis (IPN)—a viral disease of fish. In Alberta it is known only from members of the trout family. The virus is native to Alberta waters but has not been found everywhere in the province. See also Chapter 2, Section 2.2, History of Fish Culture in Alberta.

Inferior or ventral mouth—a mouth in which the upper jaw or snout projects beyond the lower jaw; as in sturgeons. The term "subterminal" is used to describe a mouth that is only modestly inferior as in longnose dace and most suckers.

Insertion (of a fin)—an end at which the fin is attached to the body, the front end of paired fins such as the pelvic and pectoral fins and the hind end of median fins such as the dorsal and anal fins.

Introduced—brought to an area from somewhere else, by means other than its own dispersal ability; usually meant to imply presence due to stocking by humans. This may refer to moving fish from Europe to Alberta (directly or indirectly such as brown trout) or moving specimens of the same species within the native range (e.g., introducing cutthroat trout or rainbow trout from one body of water to another within their native range). The term "exotic" is variously used for an organism introduced from another continent, another country, or from another drainage. See also *Native*.

Isthmus—the ventral portion of the "head" behind the lower jaw and between the opercular flaps; see Chapter 7, Fig. 7.3d.

Kype—the elongated hook of the anterior tip of the snout and lower jaw developed in large breeding males of some trout, char, and salmon.

Lateral—toward the side or on the side.
Lateral line—a series of pores along the side, variously developed or absent. The lateral line, with its receptors called neuromasts that are usually found in a canal in Alberta fishes, is a sensory organ for detecting water movement.
Lentic—standing water such as ponds, lakes, and reservoirs. See also *Lotic*.
Limnetic—the open water area of a lake that is off the substrate, shallow enough for light to penetrate, and offshore from the littoral zone. The term pelagic is used for the equivalent region in the oceans and many people also use it instead of the term limnetic for large lakes.
Limnology—the study of lakes and streams, largely to determine their biological, physical, and chemical properties, both in the present and the past.
Littoral—the relatively shallow in-shore region of a lake where rooted aquatic plants can grow. See also *Limnetic*.
Lotic—running water such as creeks, streams, and rivers. See also *Lentic*.

Macrophytes—large aquatic plants that may be rooted in the littoral zone or be found floating on or near the surface.
Marine—of the ocean. It correctly refers to the occurrence of a species in the ocean; thus, Alberta has aquatic organisms but no marine ones. However, the aquatic organisms in the inland waters of Alberta may occur in freshwater or in saline (salty) streams or lakes.
Maxilla—the bone of the upper jaw lying behind (as in salmonids) or above (as in percids) the premaxilla.
Median—situated on the middle or axial plane (= midline). Medial refers to being toward the midline, relative to another part or reference point.
Meristic—any body part occurring in serial repetition; for example, scales, fin rays, and vertebrae.
Morphometrics—the dimensional measures of the body. Morphometric characters are often expressed as ratios of the length of the individual.
Myomere (= myotome)—one of a series of muscle segments along the trunk and tail. The myomeres, important for locomotion in fish, form a zigzag pattern along the sides and are separated from each other by sheets of connective tissue called myosepta. Typically the number of myomeres equals the number of vertebrae in a fish.

Nape—the part of the body on the dorsal surface above the first few vertebrae and immediately behind the head.
Native—occurring naturally in a geographic region; that is, not there by virtue of being stocked or planted. The term may be used in a general sense as in referring to cutthroat trout being native to the Bow River drainage or in

a strict and pure sense as in referring to a given population of cutthroat trout in the Bow River system as not being native if cutthroat trout from anywhere else have been introduced.

Neuston—organisms that are floating or drifting in water currents either immediately under or above the surface film. See also *Plankton*.

Notochord—the embryonic backbone or vertebral column of vertebrates; it may persist in the adult of some fishes such as lampreys.

Opercle or operculum—the large, flat, and thin bones on each side of the head covering the gills; see also *Gill cover*.

Origin (of the dorsal, adipose, and anal fins)—the most anterior point of attachment to the body.

Ostariophysan—a member of a large superorder (Ostariophysi) of, primarily, freshwater fishes; includes milkfish, gonorynchids, minnows, loaches, suckers, tetras, and catfishes.

Otolith—a calcium carbonate structure found in the chambers (sacculus, utriculus, and lagena) of the inner ear of fishes and some other animals. Usually the one in the sacculus is the largest and it can often be used to tell the age or identity of the fish.

Palatine—a paired bone in the roof of the mouth lying on either side of the centrally located vomer and behind the premaxilla.

Papilla—a small fleshy projection.

Papillose—covered with papillae.

Parasite—organisms that live in or on other organisms and do so at their expense. Parasites often seen in Alberta fishes include tapeworms and nematodes. Some parasites have complicated life histories and individuals may live in or on different species during their life cycle.

Parr marks—vertical dark bars on the sides of some young fish such as Arctic grayling, trout, char, and mountain whitefish.

Pectoral fin—the anterior most, except in burbot, of the two paired fins; it is behind the head and either located ventrally or on the side.

Pelvic fin—the paired fin lying beneath or behind the pectoral fin, always in front of the anal fin; the pelvic fin is sometimes called the ventral fin.

Peritoneum—the membrane lining the inside of the body cavity (the coelom), seen by slitting open the fish ventrally.

Pharyngeal teeth—toothlike projections on the fifth gill arch; see introductory section of Chapter 12 on the minnow family for details.

Pharynx—the portion of the digestive tract between the mouth and the esophagus. In a fish it is the region with the gills.

Phylogeny—the evolutionary descent and relationships of a group of organisms.

Physoclistous—having lost the embryonic duct connecting the swim (air) bladder and the esophagus, generally the condition in spiny-rayed fishes such as perch.

Physostomous—having a functional duct connecting the swim (air) bladder and the esophagus, generally the condition in soft-rayed fishes such as trout and minnows.

Pisces—a collective term for all jawed fishes.

Piscivorous—fish-eating. The term may be used for fish or any other animal that eats fish.

Plankton—plants (phytoplankton) or animals (zooplankton), usually small and often microscopic, that are essentially drifting in water currents below the surface film and unable to move effectively against normal currents in a water body. The larvae of only a few fish species may be said to be planktonic; otherwise, fish are part of the nekton, animals that can swim effectively against currents. See also *Neuston*.

Plicate—having a series of wrinklelike folds of skin (plicae).

Posterior—that which is in the hind part or behind another part.

Premaxilla—the bone at the anterior tip of the upper jaw; it may form part of the border of the upper jaw as in trout or form all of the border as in perch and walleye and may bear teeth. The premaxillary groove forms the upper border of this bone.

Production—the total amount by weight of tissue formed as a result of growth of individuals over a given time period. Primary production is production created by photosynthesis; secondary production is production ultimately transformed from photosynthetic organisms. Productivity implies a rate of production whereas standing crop or biomass represents the quantity of organisms at a given period. See also *Yield*.

Profundal zone—the deep region of a body of water, usually below the level of sufficient light penetration for photosynthesis.

Protractile—capable of being extended out as in the case of the upper jaw in fish lacking a frenum.

Pseudobranch—an accessory gill on the inner surface of the opercle.

Pyloric caeca—fingerlike outpocketings of the gut located where the intestine leaves the stomach; see Chapter 7, Fig. 7.3c.

Ray of a fin—splintlike supporting structures to the fin membranes, includes both soft-rays and spines.

Redd—the gravel nest of salmonids. The eggs are deposited in the redd and remain there until they hatch.

Reservoir—a body of water with a surface elevation artificially raised above natural levels by a dam built across a river or a coulee and thereby impounding water behind it. A reservoir may exist where previously there was a river (e.g., Abraham, Gleniffer, Barrier lakes and Ghost Reservoir), a river and one or more lakes (e.g., Upper and Lower Kananaskis lakes, Lake Minnewanka, and Spray Lakes Reservoir), or where there was previously a dry coulee (e.g., Crawling Valley Reservoir). Reservoirs are usually built for the

production of hydroelectricity, flood control, or to store water for irrigation. The large hydroelectric reservoirs in Alberta typically are at their highest levels in the late summer and fall and lowest in the late winter and spring. Many reservoirs have been officially named "lakes" (e.g., Lake Minnewanka and Lower Kananaskis Lake; the official name "Spray Lakes Reservoir" recognizes that two lakes existed at the site before they were flooded by the present reservoir). We dislike this inaccurate naming and would prefer that the official names made a clear distinction between those bodies of standing water whose levels and discharge are to a large extent under artificial control and those waters whose level reflects general run-off patterns. This makes it clear that the river downstream of a reservoir (and its dam) may undergo rapid fluctuations in level, that ice on the reservoir in winter and early spring may collapse when water is withdrawn from the reservoir to meet increased power demands, and that the littoral zone will not have the same productive levels as in a (natural) lake.

The term "lake" is still appropriate when the surface levels are controlled or manipulated seasonally in order to maintain or stabilize the surface level. In such cases the seasonal fluctuation and the change from natural levels are usually less than 1 m, although long-term fluctuations may be greater. The term "artificial lake" is sometimes used for controlled lakes and for reservoirs.

Retrorse—turned backward; used to describe the condition where the premaxillary bone is turned backward, as in lake whitefish. See also *Antrorse*.

Rotenone (derris root)—a fish toxicant (poison or piscicide) derived from tropical plants of the family Leguminosae that kills fish (and many invertebrate animals) by blocking oxygen uptake. It is sometimes used to kill all the fish in a body of water for restocking or used to collect fish where other methods may prove difficult. Other substances exist that are used as fish toxicants (e.g., toxaphene and antimysin). Some toxicants have very bad side-effects (e.g., toxaphene) and many are general pesticides. The application of a fish toxicant to kill off the fishes in a body of water is often euphemistically called "rehabilitation."

Rudimentary—undeveloped or poorly developed (e.g., as in a rudimentary fin ray); the term may also be used to imply that a structure is at a primitive level of development.

Scale counts—

a) along lateral line—the number of scales along the lateral line or along its normal position and terminating at the base of the caudal fin (end of the hypural plate). Several variations of this count exist. In the salmonids often only the sensory pores along the lateral line are counted (which gives a lower count) or the scales one or two rows above the lateral line are counted (giving a higher count).

b) above the lateral line—the number of scales in a diagonal row from the origin of the dorsal fin, including any small scales, to, but not including, the lateral-line scale.

c) around the caudal peduncle—the circumference scale count around the narrowest part of the trunk between the anal fin and the tail fin.

Scute—a horny or bony plate on the head or body as in sturgeon or sticklebacks. Scutes may be simple, spiny, or keeled.

Seine net—a net that is actively moved in a body of water so as to enclose or encircle fish. It may be used in shallow water (as in a beach seine) with people dragging the net along the substrate (bottom) or it can used from a boat (as in a purse seine). The activity is called "seining". Seine nets come in a wide variety of sizes.

Snout—that part of the head in front (anterior) of the eyes.

Snout length—the distance from the anterior-most point of the snout to the front margin of the eye.

Soft-ray—a ray that is usually branched, segmented, and usually flexible. Unless otherwise stated, a dorsal and anal fin ray count includes only those which are called the principal rays (the number of branched rays plus one unbranched ray, with the last ray in dorsal and anal fin counts consisting of two ray elements in which one is branched and the other is usually unbranched). The first principal dorsal or anal fin ray is usually unbranched and is followed by a branched ray. For salmonids, some workers include all the short anterior rudimentary rays in a fin-ray count and the term principal rays includes all rays whose length is at least 1/2 the length of the longest ray.

Spine—a ray that is not branched or segmented and is usually stiff and sharp.

Standard length (SL)—the straight line distance from the anterior-most point of the snout to the end of the hypural plate.

Summerkill—the death of aquatic animals in the summer usually due to low dissolved oxygen concentrations; it is usually caused when there is a die-off of algae from a large algal bloom and oxygen is consumed by bacterial respiration during decomposition of the algae.

Synonym—each of two or more different names for the same taxon. In nomenclature this applies to the scientific names. For example, *Oncorhynchus mykiss* and *Salmo gairdneri* are synonyms. *Oncorhynchus mykiss* is regarded as the senior (vs junior) synonym because it was published first. Both are subjective synonyms (vs objective) synonyms because the names are based on different types (that ichthyologists now believe to belong to the same taxon).

Tagging—placing a mark or device on a fish or other animal in order to study movements, population size, behavior, growth, or mortality. Tags come in a wide variety of types and include radio tags that transmit a signal.

Taxon—a named taxonomic group of organisms of any rank recognized in a classification. Taxa (plural of taxon) such as brook stickleback, char, and

Salmonidae are placed in categories such as species, genus (plural genera), and family to indicate rank in a classification.

Teleost—a member of the taxon of fishes that includes all Alberta fishes except lamprey and sturgeon; it also includes such fishes as eels, herring, and flatfishes but excludes bowfin, gars, lungfishes, and sharks. Teleosts belong to the class Osteichthyes, commonly known as the "bony fishes."

Terminal mouth—a mouth with both the upper and lower jaws forming the extreme anterior tip of the head.

Total length—the straight line distance from the anterior-most point of the snout to the extreme end of the caudal fin.

Translucent—letting some light through but of a diffuse nature. In a translucent fish, as in many fry, the vertebral column and other internal parts can be seen.

Trawl—a bag-shaped net that is pulled, usually by a power boat, along the substrate (bottom trawling) or through the water column (mid-water or surface trawling) to catch fish or other animals.

Tubercles—lumps or projections on the surface, such as on the scales or fin rays in some sexually ripe fish.

Upper jaw length—distance from the tip of the snout to the end of the maxilla.

Vermiculations—markings or color patterns that are worm-like in shape.

Ventral—pertaining to on or toward the bottom or lower side.

Vertebrae—the individual bones of the vertebral column.

Vertebrate—an animal with a vertebral column. A few primitive vertebrates lack vertebrae, such as lampreys, but it is thought that they shared an evolutionary history with animals that do have vertebrae. The vertebrates in Alberta are the fishes, amphibians, reptiles, birds, and mammals. The taxon Vertebrata is usually ranked as a subphylum and placed in the phylum Chordata. Animals that are not vertebrates are termed invertebrates, a common descriptive name that is not recognized as a taxon and includes such organisms as leeches, worms, snails, clams, flies, beetles, and crustaceans.

Vomer—a median bone in the roof of the mouth; it may have teeth; see Chapter 7,Fig. 7.3e.

Weberian apparatus—the modified vertebrae and their processes (termed Weberian ossicles) that amplifies and transmits vibrations in the water from the swim bladder to the inner ear, thereby allowing the fish to "hear." Found only in otophysan fishes of the superorder Ostariophysi, fishes such as minnows, suckers, and catfishes.

Winterkill—the death of a large number of animals, such as fish, as a result of low oxygen concentrations in the water. Winterkill is most likely to occur in late winter under the ice or just as the ice leaves the lake.

Yield—the total amount harvested in a given amount of time (in the fishery).

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Index to Common and Scientific Names

NOTE: Italicized page numbers refer to the keys; plain page numbers refer to the text. In looking up information on a species, the reader should also consult the family description.

Acipenser fulvescens 99-102
Acipenseridae *89*, 97-98, 375
African jewelfish 372-73
Agosia 174
American eel 376
amur, white 378
angelfish, freshwater 385
Anguilla rostrata 376
Anguillidae 376
Aplodinotus grunniens 385
Arctic char 381
Arctic grayling *226*, 253-56
Arctic lamprey 95-96
Atlantic salmon 380

bass, largemouth 383
bass, smallmouth 383-84
blackfin cisco 379
blacknose dace 379
blacknose shiner 379
brassy minnow *122*, 132-35
bridgelip sucker 202
brook stickleback *318*, 319-23
brook trout *229*, 287-90
brown trout *229*, 274-78
bull trout *229*, 279-83
bull char 283
bullhead catfish *89*, 211-12
burbot 304-7

Carassius auratus 376
carp, common 376
carp, grass 376-78
Carpiodes cyprinus 181, 185-88
catfish *89*, 211-12
catfish, channel 211
Catostomidae *90*, 179-81
Catostomus catostomus 184, 189-92
Catostomus columbianus 202
Catostomus commersoni 184, 193-96
Catostomus macrocheilus 184, 197-99
Catostomus platyrhynchus 184, 200-203
Centrarchidae 383-84
channel catfish 211
char, Arctic 381
char, bull 283
chinook salmon 379
chub, flathead *118*, 163-66
chub, lake *120*, 124-27
chum salmon 379

Chrosomus 154, 158
Cichlasoma nigrofasciatum 385
Cichlid, convict 385
Cichlidae *92*, 371, 385
cisco *226*, 231-34
cisco, blackfin 379
cisco, shortjaw *227*, 235-36
cod *91*, 303
coho salmon 380
common carp 376
convict cichlid 385
cony 381
Coregonus artedi 226, 231-34
Coregonus clupeaformis 227, 237-42
Coregonus nasus 242
Coregonus nigripinnis 379
Coregonus zenithicus 227, 235-36
Cottidae *92*, 331-32, 382
Cottus asper 382-83
Cottus bairdi 340
Cottus cognatus 333, 334-37
Cottus confusus 333, 338-41
Cottus rhotheus 340, 383
Cottus ricei 333, 342-45
Couesius plumbeus 120, 124-27
Ctenopharyngodon idella 376-78
Culaea inconstans 318, 319-23
cutthroat trout *230*, 257-62
Cyprinidae *90*, 115-17, 376
Cyprinus carpio 376

dace, blacknose 379
dace, finescale *121*, 155-58
dace, longnose *118*, 170-74
dace, northern redbelly *121*, 151-54
dace, pearl *121*, 136-39
darter, Iowa *351*, 352-54
darter, johnny 385
deepwater sculpin *333*, 346-47
Dolly Varden 282, 284
Dolly Varden, northern *229*, 284-86
drum 385

Eastern brook trout 287
eel, American 376
emerald shiner *120*, 140-43
Esocidae *90*, 217
Esox lucius 218-22
Etheostoma exile 351, 352-54
Etheostoma nigrum 385

fathead minnow *122*, 159-62
finescale dace *121*, 155-58
flathead chub *118*, 163-66
freshwater angelfish 385
freshwater drum 385

Gadidae *91*, 303
Gambusia affinis 310, 311-13
gar 375
Gasterosteidae *92*, 317-18
Gasterosteus aculeatus 318, 328-29
golden shiner 378
golden trout *230*, 272-73
goldeye *105*, 106-10
goldfish 376
grass carp 376-78
grayling 252, 256
grayling, Arctic *226*, 253-56
green swordtail 382
guppy 382

Hemichromis bimaculatus 372-73
Hiodon alosoides 105, 106-10
Hiodon tergisus 105, 111-14
Hiodontidae *90*, 103-4
Hybognathus argyritis 122, 128-31
Hybognathus hankinsoni 122, 132-35
Hybognathus nuchalis 131
Hybopsis 127, 165

Ictaluridae *89*, 211-12
Ictalurus punctatus 211
inconnu 381
Iowa darter *351*, 352-54

jackfish 218
jewelfish, African 372-73
johnny darter 385

koi 376
kokanee 380

lake chub *120*, 124-27
lake sturgeon 99-102
lake trout *228*, 291-95
lake whitefish *227*, 237-42
Lampetra japonica 95-96
lamprey *89*, 93-94
lamprey, Arctic 95-96
largemouth bass 383
largescale sucker *184*, 197-99
leopard dace 174, 379
lepisosteidae 375-76
Lepomis gibbosus 383
ling 304
lingcod 303
livebearer *91*, 382
loche 304
logperch *351*, 355-56
longnose dace *118*, 170-74
longnose sucker *184*, 189-92
Lota lota 304-7

Margariscus margarita 121, 136-39
maria 304
Micropterus dolomieu 383-84
Micropterus salmoides 383
minnow *90*, 115-17, 376
minnow, brassy *122*, 132-35
minnow, fathead *122*, 159-62
minnow, western silvery *122*, 128-31
molly, sailfin *310*, 314-16
mooneye *90*, 103-4, *105*, 111-14
mosquitofish, western *310*, 311-13
mottled sculpin 340
mountain sucker *184*, 200-203
mountain whitefish *228*, 248-52
Moxostoma anisurum 183, 204-6
Moxostoma macrolepidotum 183, 207-9
Mylocheilus caurinus 378
Myoxocephalus thompsoni 333, 346-47

ninespine stickleback *318*, 324-27
northern Dolly Varden *229*, 284-86
northern pike 218-22
northern redbelly dace *121*, 151-54
northern squawfish *121*, 167-69
Notemigonus crysoleucas 378
Notropis atherinoides 120, 140-43
Notropis blennius 123, 144-46
Notropis heterolepis 146, 379
Notropis hudsonius 123, 147-50
Notropis jordani 146
Noturus flavus 213-15

Oncorhynchus 270
Oncorhynchus aguabonita 230, 272-73
Oncorhynchus clarki 230, 257-62
Oncorhynchus clarki bouvieri 262
Oncorhynchus clarki lewisi 259, 262
Oncorhynchus keta 379
Oncorhynchus kisutch 380
Oncorhynchus mykiss 230, 263-71
Oncorhynchus nerka 380
Oncorhynchus newberryi 270
Oncorhynchus tshawytscha 379

Pacific salmon 270
paddlefish 98
Pantosteus 203
Parasalmo 270
peamouth 378
pearl dace *121*, 136-39
Perca flavescens 351, 357-61
perch *91*, 349
perch, pike 366
perch, yellow *351*, 357-61
Percidae *91*, 349, 385
Percina caprodes 351, 355-56
Percopsidae *91*, 297

Percopsis omiscomaycus 298-301
Petromyzontidae *89*, 93-94
Pfrille 158
Phoxinus eos 121, 151-54
Phoxinus neogaeus 121, 155-58
pickerel 369
pike *90*, 217
pike perch 366
pike, northern 218-22
Pimephales promelas 122, 159-62
Platygobio gracilis 118, 163-66
Poecilia latipinna 310, 314-16
Poecilia reticulata 382
Poeciliidae *91*, 309, 382
prickly sculpin 382-83
Prosopium coulteri 227, 243-45
Prosopium cylindraceum 228, 246-47
Prosopium williamsoni 228, 248-52
Pterophyllum scalare 385
Ptychocheilus oregonensis 121, 167-69
pumpkinseed 383
Pungitius pungitius 318, 324-27
pygmy whitefish *227*, 243-45

Quebec red trout 381
quillback *181*, 185-88

rainbow trout *230*, 263-71
redband trout 269
redhorse, shorthead *183*, 207-9
redhorse, silver *183*, 204-6
redside shiner *120*, 175-78
Rhabdofario 270
Rhinichthys atratulus 379
Rhinichthys cataractae 118, 170-74
Rhinichthys falcatus 174, 379
Rhinichthys osculus 174, 379
Rhinichthys umatilla 379
Richardsonius balteatus 120, 175-78
river shiner *123*, 144-46
round whitefish *228*, 246-47

sailfin molly *310*, 314-16
Salmo aguabonita 230, 272
Salmo clarki 230, 257
Salmo gairdneri 230, 263
Salmo newberryi 269
Salmo salar 380
Salmo trutta 229, 274-78
salmon, Atlantic 380
salmon, chinook 379
salmon, chum 379
salmon, coho 380
salmon, Pacific 270
Salmonidae *89*, 223-24, 379
Salvelinus alpinus 381
Salvelinus alpinus marstoni 381
Salvelinus confluentus 229, 279-83
Salvelinus fontinalis 229, 287-90
Salvelinus malma malma 229, 284-86
Salvelinus marstoni 381
Salvelinus namaycush 228, 291-95
sauger *351*, 362-65
Scaphirhynchus 98, 375
Sciaenidae 385
sculpin *92*, 331, 382
sculpin, deepwater *333*, 346-47
sculpin, mottled 340
sculpin, prickly 382-83
sculpin, shorthead *333*, 338-41
sculpin, slimy *333*, 334-37
sculpin, spoonhead *333*, 342-45
sculpin, torrent 340, 383
Semotilus margarita 136
shiner, blacknose 379
shiner, emerald *120*, 140-43
shiner, golden 378
shiner, redside *120*, 175-78
shiner, river *123*, 144-46
shiner, spottail *123*, 147-50
shorthead redhorse *183*, 207-9
shorthead sculpin *333*, 338-41
shortjaw cisco *227*, 235-36

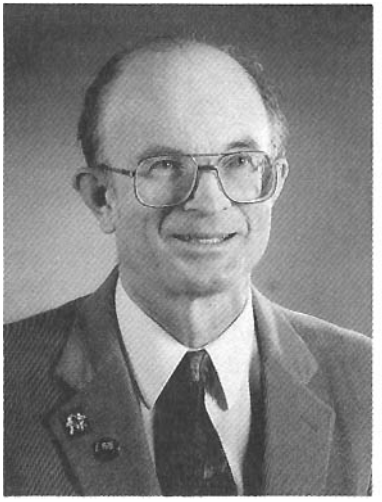
silver mutant 218, 220
silver redhorse *183*, 204-6
slimy sculpin *333*, 334-37
smallmouth bass 383-84
speckled dace 174, 379
speckled trout 287
splake 294
spoonhead sculpin *333*, 342-45
spottail shiner *123*, 147-50
squawfish, northern *121*, 167-69
Stenodus leucichthys 381
stickleback *92*, 317-18
stickleback, brook *318*, 319-23
stickleback, ninespine *318*, 324-27
stickleback, threespine *318*, 328-29
Stizostedion canadense 351, 362-65
Stizostedion vitreum vitreum 351, 366-70
stonecat 213-15
sturgeon *89*, 97-98, 375
sturgeon, lake 99-102
sucker *90*, 179-81
sucker, largescale *184*, 197-99
sucker, longnose *184*, 189-92
sucker, mountain *184*, 200-203
sucker, white *184*, 193-96
sunfish 383
swordtail, green 382

threespine stickleback *318*, 328-29
Thymallus arcticus 226, 253-56
tiger trout 277
torrent sculpin 340, 383
trout *89*, 223
trout, brook *229*, 287-90
trout, brown *229*, 274-78
trout, bull *229*, 279-83
trout, cutthroat *230*, 257-62
trout, Eastern brook 287
trout, golden *230*, 272-73
trout, lake *228*, 291-95
trout, Quebec red 381
trout, rainbow *230*, 263-71
trout, redband 269
trout, speckled 287
trout, tiger 277
trout, westslope cutthroat 259, 262
trout, yellowstone cutthroat 262
trout-perch *91*, 297-301
tullibee 231

walleye *351*, 366-70
western mosquitofish *310*, 311-13
western silvery minnow *122*, 128-31
westslope cutthroat trout 259, 262
white amur 378
white sucker *184*, 193-96
whitefish, lake *227*, 237-42
whitefish, mountain *228*, 248-52
whitefish, pygmy *227*, 243-45
whitefish, round *228*, 246-47

Xiphophorus helleri 382

yellow perch *351*, 357-61
yellowstone cutthroat trout 262



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